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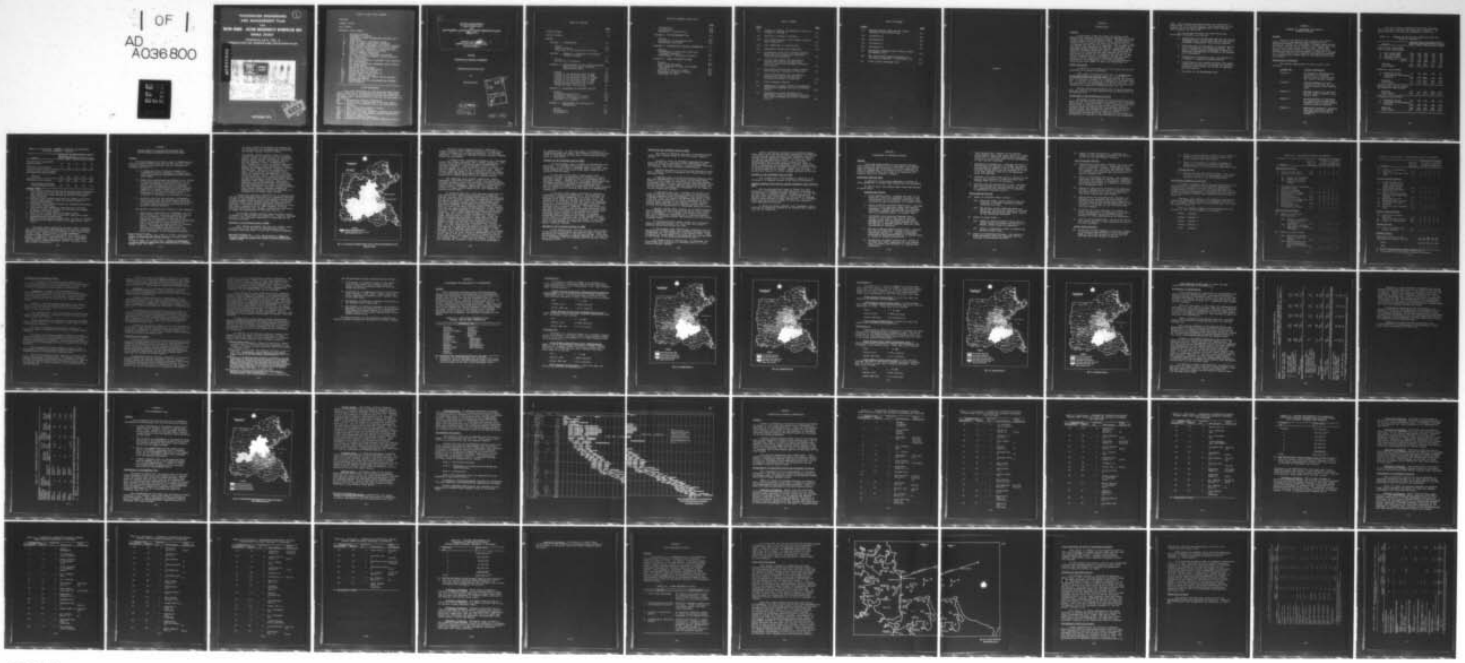

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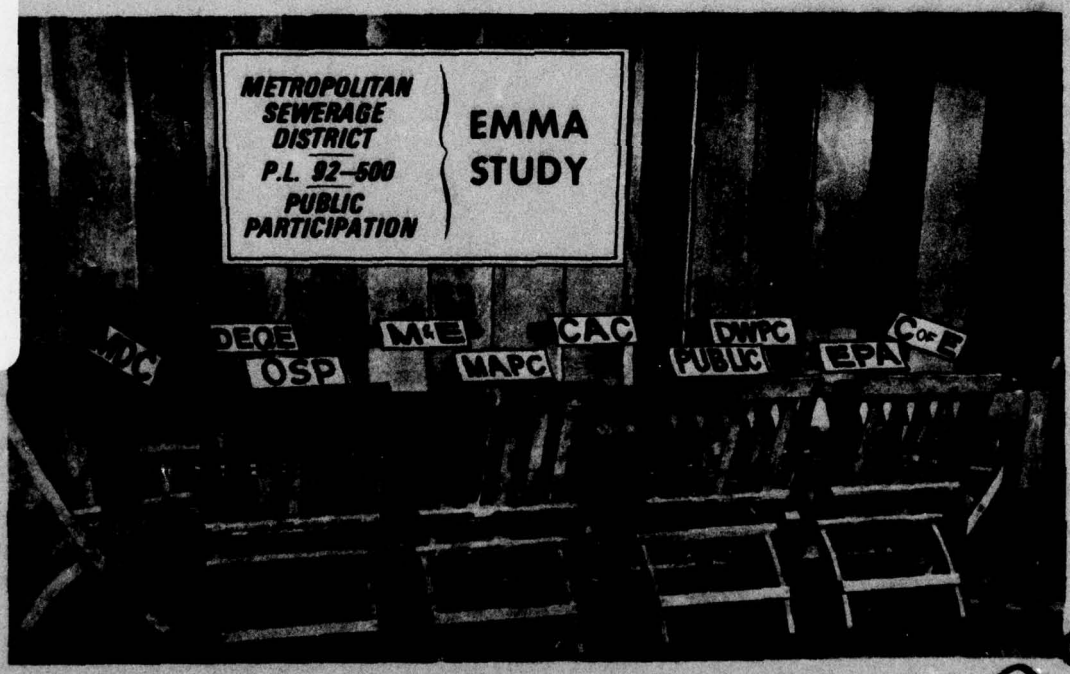
WASTEWATER ENGINEERING AND MANAGEMENT PLAN

FOR

BOSTON HARBOR - EASTERN MASSACHUSETTS METROPOLITAN AREA

EMMA STUDY

TECHNICAL DATA VOL. 6
FORMULATION OF WASTEWATER UTILIZATION PLAN



OCTOBER 1975

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COVER PHOTOGRAPH

The cover photograph on this Technical Data Volume depicts Room 206 at the Metropolitan District Commission where the Technical Subcommittee Meetings were held during the EMMA Study. Abbreviations as used on the photograph are as follows:

MDC = Metropolitan District Commission
EPA = United States Environmental Protection Agency
Public = Members of the general public who attended the meetings
MAPC = Metropolitan Area Planning Council
OSP = Office of State Planning
C of E = United States Army, Engineer Division, New England
DEQE = Department of Environmental Quality Engineering
M&E = Metcalf & Eddy, Inc.
CAC = Citizens Advisory Committee
DWPC = Massachusetts Division of Water Pollution Control

(6)

WASTEWATER ENGINEERING AND MANAGEMENT PLAN FOR BOSTON HARBOR – EASTERN MASSACHUSETTS METROPOLITAN AREA EMMA STUDY.

TECHNICAL DATA Volume 6. FORMULATION OF THE WASTEWATER UTILIZATION PLAN.

FOR THE

METROPOLITAN DISTRICT COMMISSION

COMMONWEALTH OF MASSACHUSETTS

BY

METCALF & EDDY, INC.

(11) OCTOBER 1975

(12) 67p.

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CHAPTER 1

INTRODUCTION

General

Forty-three cities and towns now belong to the Metropolitan Sewerage District which is administered by the Metropolitan District Commission (MDC). The MDC maintains primary sewage treatment plants at Deer Island and Nut Island in Boston Harbor and about 225 miles of trunk lines, 12 pumping stations and four headworks. The primary treatment plants are operating at capacity. The present EPA discharge permits require that the MDC expand and upgrade them with secondary treatment plants. The first step in doing so is to determine how many communities should in the future be served by the upgraded Deer Island and Nut Island treatment plants. Therefore, the MDC has undertaken a study of anticipated wastewater management problems in 109 communities of the Eastern Massachusetts Metropolitan Area (EMMA) to make this determination.

Report Structure

As shown on the inside cover, the study results are presented in a series of volumes.

This report is Technical Data Vol. 6, Formulation of the Wastewater Utilization Plan, and covers the deliberative process that was followed between the development of Concepts 1 through 4 as discussed in Technical Data Vol. 4, Concept 5 as discussed in Technical Data Vol. 5 and the adoption of the Recommended Plan by The Technical Subcommittee as presented in Technical Data Vol. 15.

Various interim alternatives are presented together with the reasons for their modifications in arriving at the Recommended Plan.

Chronology of the Deliberative Process

Following the development of the approximate service areas for the four water oriented concepts it was determined that Concept 5 (land oriented), should be based on the same service area as Concept 4, and to the extent possible, treatment would be accomplished through land application systems rather than through the type of advanced wastewater treatment facilities utilized in Concept 4. A deliberative process was then undertaken by the Technical Subcommittee to proceed to the selection of the Recommended

Plan. This process included as input the evaluation of desires and concerns made known to the study group by the general public at public meetings where these concepts were presented and described.

The chronology of events followed during this deliberative process is as follows:

1. Establishment of the maximum Deer and Nut Island treatment plant service area and the deletion of peripheral communities from further analysis.

2. Identification and evaluation of various factors to be included in the selection process. For this, a rating form was developed to assist the Technical Subcommittee in listing of the factors to be considered.

3. Elimination of Concepts 3 and 5 and adoption of a concept of moderate decentralization.

4. In addition to the concepts studied, four additional alternatives were developed for satellite treatment plants under the concept of moderate decentralization.

5. Selection of the Recommended Plan.

CHAPTER 2

SUMMARY OF WASTEWATER UTILIZATION CONCEPTS STUDIED

General

Prior to the start of this project, four alternative service area concepts were established for developing sewerage and wastewater treatment opportunities relative to service by an expanded or contracted Deer and Nut Island treatment plant service area. These four service areas were studied in terms of water oriented disposal systems and were designated as Concepts 1 through 4. A fifth concept utilizing land application techniques for treatment was studied based on the same service area as Concept 4.

Description of Concepts

The general description of each concept is as follows:

Concept No.	Concept description
Concept 1	No expansion, upgrading systems within the present service area of the Deer and Nut Island treatment plants.
Concept 2	Limited expansion or contraction of the Deer and Nut Island treatment Plant service area.
Concept 3	Maximum expansion of the Deer and Nut Island treatment plant service area.
Concept 4	Decentralization of treatment by construction of additional treatment plants within present service areas and systems.
Concept 5	Wastewater management utilizing land application for system configurations developed in Concept 4.

For each concept, sewerage systems and treatment facilities were developed and costs were estimated. The major statistics for each are presented in Table 2-1.

TABLE 2-1. SUMMARY OF CAPITAL AND OPERATION COSTS FOR CONCEPTS 1 THROUGH 5

System	Capital costs (millions of $) Con 1	Con 2	Con 3	Con 4	Con 5
Deer and Nut Island WWTP service area improvements					
1. Deer Island WWTP	260	236	260	194	194
2. Nut Island WWTP	231	135	248	146	146
3. Pumping Stations	19	19	19	19	19
4. Interceptors - Present	118	49	160	57	57
- Future	47	17	138	15	15
Subtotal	675	456	825	431	431
Local share	67.5	45.6	82.5	43.1	43.1
Satellite area systems					
1. Treatment plants	31	247	None	336	251
2. Interceptors and pumping stations	20	28	None	31	327
Subtotal	51	275	None	367	578
Local share	5.1	27.5	None	36.7	57.8
Subtotal Deer and Nut Island and Satellite area systems					
Subtotal	726	731	825	798	1009
Local share	72.6	73.1	82.5	79.8	100.9
Peripheral area systems					
1. Treatment plants	182	182	182	182	168
2. Interceptors and pumping stations	86	86	86	86	86
Subtotal	268	268	268	268	254
Local share	26.8	26.8	26.8	26.8	25.4

TABLE 2-1 (Continued). SUMMARY OF CAPITAL AND OPERATION COSTS FOR CONCEPTS 1 THROUGH 5

System	Operation and maintenance costs (millions of $) Con 1	Con 2	Con 3	Con 4	Con 5
Deer and Nut Island WWTP service areas	17	15	17	14	14
Satellite area systems	4	24	1	33	12
Subtotal Deer and Nut Island and Satellite area systems					
Subtotal	21	39	18	47	26
Peripheral area systems	17	17	17	17	16
Total annual operation and maintenance costs	38	56	35	64	42

GENERAL NOTES:

1. Deer and Nut Island service areas include those municipalities tributary to Deer and Nut Island wastewater treatment plants under each concept as shown on the appropriate figures.
2. Satellite area systems vary with the change in the Deer and Nut Island service areas and include present or possible MDC members.
3. Peripheral area systems include the remaining municipalities in the Study Area.
4. Local share costs represent that portion to be paid locally. Ninety (90) percent of the costs are funded by Federal and state grants.
5. Costs do not include local collection sewers.
6. Costs are at present day prices (ENR 2200) and include engineering and contingencies.
7. Satellite area systems, capital cost, Concept 5, includes $28 million for lands Concepts 1-4 do not include land costs.

The above costs, except for Concept 5 which includes cost of regionalized sludge management facilities, represent individual incineration at each satellite plant where flows exceed 10 mgd. Other options of sludge management covering sludge disposal in combination with other solid wastes, in addition to regionalization, were investigated. Findings showed that these can be achieved at lower cost than individual sludge management systems included in the costs shown in Table 2-1.

CHAPTER 3

ESTABLISHMENT OF THE MAXIMUM FEASIBLE DEER AND NUT ISLAND TREATMENT PLANT SERVICE AREA

General

The methodology and criteria used for developing the maximum feasible service area for the Deer and Nut Island treatment plants were as follows, and are discussed in Technical Data Vol. 4:

1. A review was made of previous studies and recommendations for sewerage in various locations of the Eastern Massachusetts Metropolitan Area (EMMA).

2. These were supplemented and updated with a review of projected needs and opportunities. In this review, consideration was given to providing water reuse possibilities; recent treatment requirements for Massachusetts streams (pending completion of basin plans); timing of sewerage needs in the various communities; location of discharges in relation to flows; and to retention of discharges in the basin of origin.

3. Possible solutions and treatment requirements were reviewed with the Massachusetts Division of Water Pollution Control to obtain their input on present-day problems and near-future water pollution control actions.

Two general conclusions were formed by this analysis:

1. Additional concentration of discharges into the Boston Harbor for coastline communities should not be considered. This limits, along the coastline, the maximum Deer and Nut Island service area boundaries to the present communities which are essentially those bordering the Boston Harbor and including Revere, an existing member. Consideration was given to the feasibility of Nahant joining the MDC, but its joining the Lynn system was found to be a better solution*. At the southern boundary,

*Camp, Dresser & McKee, Inc., Town of Nahant, Massachusetts, Report on Sewerage and Sewage Disposal, December 1968.
also
Metcalf & Eddy, Inc., Lynn, Mass., Report to Department of Public Works on Additions and Improvements to Sewerage System, Sept. 29, 1972.

the Town of Hull investigated the feasibility of joining MDC, but concluded that a municipal system was a better solution there*.

2. The maximum possible service area to be considered inland, in addition to that presently served, should be that tributary to the Boston Harbor rivers, namely, the Charles, Mystic, and the Neponset rivers. Communities in this category are: Lincoln, Weston, Sherborn, Dover, Holliston, Millis, Medfield, Milford, Medway, Bellingham (partly), Franklin, Norfolk, and Wrentham. There are two exceptions to this: one is the Town of Lynnfield, which previous studies have demonstrated to be best served by the MDC system. The other exception is the possibility of an expanded system also serving the unsewered areas around MDC's Sudbury Reservoir water supply system. This would generally include Southborough and Hopkinton. Although Westborough and a part of Marlborough are also tributary to the MDC's Sudbury Reservoir water supply system, sewerage systems have already been developed there for discharge not tributary to the water supply system.

Serving the remaining communities by an expanded Deer and Nut Island sewerage system was not considered desirable because of long transport relief requirements; because such a system negates reuse possibilities; because out-of-basin transfers would occur; because additional flows would be diverted to the Boston Harbor aggravating problems of treatment space, combined and old sewer remedial needs and facility capacities; and, because construction costs would be higher as demonstrated in Technical Data Vol. 4.

The maximum feasible service area selected is shown in Figure 3-1 and includes 60 communities. Possible sewerage service to the remaining communities is discussed in the following sections.

Systems in the Northeast Area of EMMA

Lynn, Saugus and Nahant form the Lynn system, which is presently in the process of implementation with a secondary treatment plant in Lynn and a coastal discharge.

*Whitman & Howard, Inc., Hull, Massachusetts, Report on Proposed Sewerage System and Sewage Treatment Facilities, August, 1969.

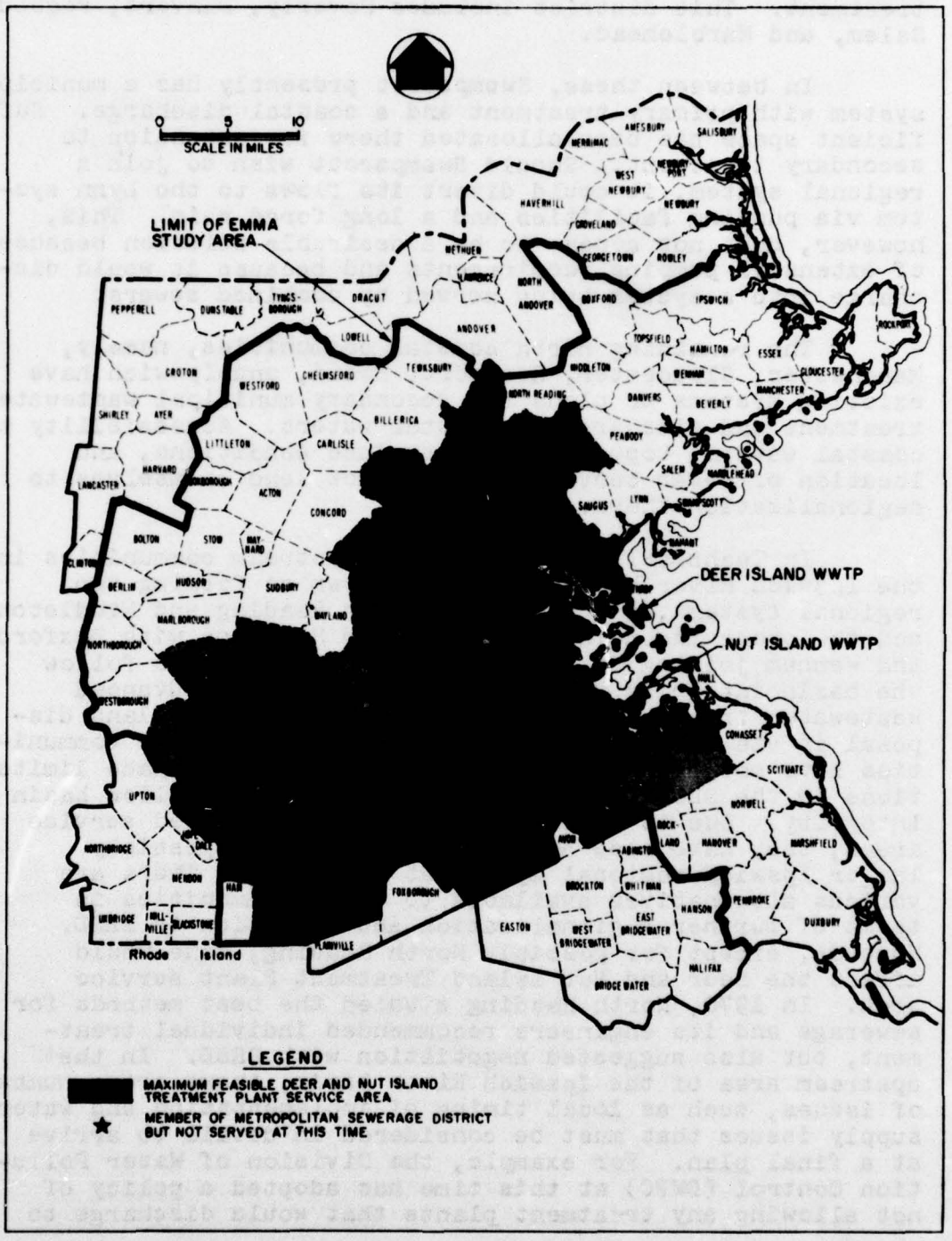

FIG. 3-1 MAXIMUM FEASIBLE DEER AND NUT ISLAND TREATMENT PLANT SERVICE AREA

The South Essex Sewerage District (SESD) has a primary treatment plant under construction in Salem with a coastal discharge and is planning extension to secondary treatment. This district includes Beverly, Danvers, Peabody, Salem, and Marblehead.

In between these, Swampscott presently has a municipal system with primary treatment and a coastal discharge. Sufficient space has been allocated there for extension to secondary treatment. Should Swampscott wish to join a regional system, it could divert its flows to the Lynn system via pumping facilities and a long force main. This, however, does not appear to be a desirable solution because of extensive pumping requirements and because it would discharge into a system being served by combined sewers.

The remaining north coastal communities, namely, Manchester, Gloucester, Rockport, Essex, and Ipswich have existing systems or plans for secondary municipal wastewater treatment and discharge to coastal waters. Accessibility to coastal waters, topography, subsurface conditions, and location of sewer service areas do not lend themselves to regionalization there.

In Technical Data Vol. 4 the upstream communities in the Ipswich River basin have been shown as forming two regional systems, one including North Reading and Middleton, and the other including Topsfield and Hamilton with Boxford and Wenham joining at a later date. These plants follow the basin integrity concept and would require advanced wastewater treatment or, possibly, could support land disposal in view of the small projected flows. These communities have not been included in the SESD due to space limitations in the SESD facilities, and in order to follow basin integrity. Due to their expected small scattered service areas, they have also not been included in a possibly larger Ipswich regional system at this time. There are various alternatives available to these communities in terms of further regionalization and diversion to SESD. However, except for possibly North Reading, none would affect the Deer and Nut Island Treatment Plant service area. In 1970, North Reading studied the best methods for sewerage and its engineers recommended individual treatment, but also suggested negotiation with SESD. In the upstream area of the Ipswich River basin, there are a number of issues, such as local timing of implementation and water supply issues that must be considered in detail to arrive at a final plan. For example, the Division of Water Pollution Control (DWPC) at this time has adopted a policy of not allowing any treatment plants that would discharge to

the Ipswich River. On the other hand, in recognition of increasing demand for water, the Division of Water Resources (DWR) is considering various ways of providing additional water to this basin.

Systems in the Southeast Area of EMMA

In the southeast area, a number of alternatives are available. The systems in Technical Data Vol. 4 were established on the basis of drainage basin integrity, where flows originating in the North River basin would not be diverted from the basin.

In the case of the south coastal area, Hull, Cohasset, Scituate and Marshfield are expected to retain municipal systems. Presently, Hull is proceeding with a municipal system. Cohasset has a municipal system providing secondary treatment, Scituate is proceeding with plans for improvements and Marshfield just completed planning to expand its system on a municipal basis, but providing for the possibility of serving small parts of neighboring communities.

In the North River basin, Rockland is expected to continue as a municipal system due to its relatively new plant with a planned upgrading of the plant in order to maintain river flows at the head end of the river. The communities of Pembroke, Hanover and Norwell in Technical Data Vol. 4 were grouped to form the North River regional system with a plant in Scituate providing secondary treatment with a coastal discharge. The North River area has other alternatives, such as diverting wastewater from Pembroke out of the basin to the planned Old Colony Water Pollution Control District with Hanover and Norwell providing joint treatment in the basin, or possibly diverting Pembroke, Hanover and Norwell wastewaters out of the basin to a regional plant in Marshfield. Rockland could be incorporated in any of the plans. In any event, none of these systems are expected to affect the Boston Harbor tributary systems.

Systems in the Southern Section of EMMA

In the southern part, the Town of Avon, which drains to the Taunton River basin, has been included in plans for diverting its wastewater to the Brockton system. This plan was proposed by engineers studying sewerage for the town and is in conformance with the areawide plan of the Old Colony Planning District.

Systems in the Northwest Area of EMMA

The towns of Tewksbury and part of Chelmsford would follow their present plans to join the Lowell regional system.

Billerica, which is presently upgrading its plant, would continue as a municipal system discharging after treatment to the Concord River. It would include treatment for Carlisle, when that community needs service.

Westford and parts of Littleton and Chelmsford would form a regional system discharging into Stony Brook or the Merrimack River.

A regional plant in Concord providing advanced treatment and discharging into the Concord River would serve Concord, Acton, a part of Littleton, and possibly Maynard. Boxborough could also join this district when sewerage there becomes necessary. Other regional possibilities exist for the Concord area including the enlargement of the region to include Sudbury and Wayland.

In Technical Data Vol. 4, Sudbury and Wayland were shown to form its own district and would be served by an advanced treatment plant discharging to the Concord River. A separate plant for Sudbury and Wayland was shown in this study due to the proximity of these communities to the Sudbury River, because of the distance of their expected service areas from the Concord regional system, and to provide for the distribution of discharges along the river.

However, recent basin planning by the DWPC indicates that discharge into the Sudbury River above Concord would not be desireable. For a longer term future, this would have to be taken into consideration in locating plants in the area or providing further regionalization at the Concord Treatment Plant.

In the Assabet River basin, Hudson would initially remain a municipal system, but could join in a future regional system with Bolton and Stow.

At the present time, Westborough, Shrewsbury and the western part of Marlborough have secondary treatment plants discharging into the headwaters of the Assabet River. Some allowance for future needs of Northborough has been provided in the design of the Marlborough Westerly plant.

The western part of Marlborough, Northborough, and Westborough were considered in Technical Data Vol. 4 as joining regional systems.

Recent information reflected in the Phase I Basin Plans which cover the Marlborough, Shrewsbury, Northborough and Westborough areas indicates that Shrewsbury and Westborough should regionalize themselves instead of going to the Marlborough Westerly facility. In this case, the Marlborough Westerly Plant would receive flow from Northborough, and provide secondary treatment while the towns of Shrewsbury and Westborough would be combined into an advanced wastewater treatment facility located at a site to be determined in the future. Again, none of these systems are expected to affect systems operated by the MDC.

Systems in the Southwest Area of EMMA

The southern part of Bellingham is expected to be oriented to a regional system in the Town of Blackstone.

Maximum Feasible Deer and Nut Island Treatment Plant Service Area

The 60 municipalities shown in Figure 3-1 were selected as the maximum area that should be considered in the expansion of sewerage systems tributary to the MDC Deer and Nut Island treatment plants. Further engineering analyses were then concentrated in this study on sewerage service opportunities to these communities. The peripheral areas were not analyzed further to find their desirable local engineering solutions.

It should be noted, however, that management opportunities of peripheral systems by an expanded MDC organization are not ruled out.

CHAPTER 4

EVALUATION OF CONCEPTS STUDIED

General

Following establishment of the maximum feasible service area and deletion of the peripheral area communities, evaluation was undertaken of the five concepts in terms of communities to be served by Deer Island and Nut Island treatment plants and those to be served by sub-regional satellite treatment systems.

Evaluation Factors Used

In addition to the costs presented in Chapter 2, other parameters of concern were identified and considered.

To aid in this, the factors were listed and defined as shown below.

Engineering Factors

1. Total Capital Costs - includes the cost of all materials, labor and equipment relating to the construction of all treatment facilities, pumping stations and interceptors - at current costs.

2. Annual Operation and Maintenance Costs - includes the cost of all materials, labor and supplies necessary to operate and maintain the treatment facilities, pumping stations and interceptors, based on projected flows - at current costs.

3. Conformance with Existing Sewerage Plans - relates to the effect that each of the five concepts would have on existing plans being implemented by the individual communities and the MDC and on adopted regional plans and state implementation schedules.

4. Ability to Handle Unanticipated Flows - reflects the ease and additional expense of providing additional capacity in treatment facilities, interceptors and pumping stations to handle flows in excess of present projections.

5. Suitability to Phased Construction - refers to the ease with which components of each concept could be broken into portions for construction scheduling.

6. Plant Reliability - relates to the adverse environmental impact that would result if a plant failed and the untreated wastes were discharged directly to a receiving water and the probability of such failure occurring.

7. Generation of Sludge Ash - although the costs of construction and operation of sludge facilities are included in numbers 1 and 2, the quantity of residual solids which must be disposed of is not. It is this quantity which is to be addressed under this heading.

8. Potential for Direct Water Reuse - relates to the quality and locations of plant effluents discharged under each of the concepts.

9. Availability and Suitability of Land - includes both the availability and suitability of land for construction and possible future expansion of wastewater treatment plants.

Water Quality Factors

10. Impact on In-Stream Water Quality -

    10a. Resultant water quality after mixing and dilution of effluent, assuming 10-year, seven-day low flow.

    10b. The ability of the receiving waters to handle the quantity and quality of effluent discharged and maintain high water quality at all downstream locations.

11. Effect on River Flows -

    11a. Degree to which wastewater flows are retained within the basins, and sections of basins, wherein they are generated.

    11b. Effect of wastewater flows on minimum and maximum stream flows.

12. Impact on Groundwater Recharge - the degree to which wastewater flows are available for the recharge of groundwater aquifers.

13. Impact on Fish and Wildlife - potential for changes in the abundance, diversity and distribution of fish and wildlife species.

Socio-economic Factors.

14. Compatibility with State, Regional and Local Land Use and Development Plans - comparison of proposed collection, treatment, and disposal sites with regional and local land use plans to identify conflicts with planned uses and failures to support planned uses.

15. Effect on Employment and Income - net changes in employment and income of the region's residents resulting from changes in industrial, commercial and service activities as a result of the wastewater management plan.

16. Impacts on Agriculture, Forestry and Commercial Fishing - changes in the yield of agricultural and forestry activities and in the yield of commercial fishery and shellfishery.

17. Opportunities for Recreation and Tourism - net changes in the potential for utilization of existing water related recreational facilities and sport fishing and hunting opportunities; the utility of, or access to, new facilities that could be created.

18. Potential for Local Autonomy - the degree to which centralization of sewerage services forecloses management options affording great autonomy to local municipalities or subregions.

19. Costs to Local Communities - the relative financial burden imposed on each community by each of the five concepts.

Public Health Factors.

20. Protection of Water Supplies - potential changes in the quality and quantity of water presently used, or which may be used in the future, for drinking and other domestic purposes.

21. Effect on Noise Levels - impact of net changes in ambient noise levels which would result from daily operation and maintenance.

22. Impact on Air Quality - impact of changes in ambient air quality which would result from implementation of the wastewater management plan.

Design Factors.

23. Visual, Cultural and Design Impacts - the visual and cultural impact of the proposed wastewater treatment plants on the surrounding area.

Qualitative Analysis of Concepts

In order to evaluate the 23 factors identified in the previous section, members of the Technical Subcommittee independently assigned a relative rank of significance using a range of one to 10, with one being the best, most important or most significant. Following this, the rankings of all Subcommittee members were averaged and are shown in Table 4-1.

Similarly, each member of the Technical Subcommittee ranked the alternatives in order of preference for each of the 23 factors. These, again, were averaged and the results are shown in Table 4-1.

Table 4-1 shows a summary of the rankings with the concepts in the following order of preference.

First	Concept 1
Second	Concept 4
Third	Concept 2
Fourth	Concept 3
Fifth	Concept 5

TABLE 4-1. QUALITATIVE RATING OF CONCEPTS

Factor	Relative rank of factor(1)	Ranking of concepts in order of preference(2) Concept No. 1	2	3	4	5
Engineering Factors						
1. Total Capital Costs	3.6	1	2	4	3	5
2. Annual O & M Costs	2.7	2	4	1	5	3
2a. Demand for chemicals						
2b. Demand for energy						
2c. Manpower requirements						
3. Conformance with Existing Sewerage Plans	4.4	1	2	4	3	5
4. Ability to Handle Unanticipated Flows	3.6	3	2	5	1	4
5. Suitability to Phased Construction	5.1	3	2	5	1	4
6. Plant Reliability	2.8	2	3	1	4	5
7. Generation of Sludge Ash	5.1	1	4	1	4	1
8. Potential for Direct Water Reuse	3.8	3	2	5	1	4
9. Availability and Suitability of Land	4.1	1	3	1	3	5
Water Quality Factors						
10. Impact on In-Stream Water Quality						
10a. Effect of effluents on water quality standards	2.0	2	3	1	4	5
10b. Capacity of receiving waters to handle effluents	1.6	2	3	1	4	5
11. Effect on River Flows						
11a. Ability to retain flows in basin of origin	2.9	3	2	5	1	3
11b. Opportunities for flow augmentation and flow stabilization	3.2	4	2	5	1	3

TABLE 4-1 (Continued). QUALITATIVE RATING OF CONCEPTS

Factor	Relative rank of factor(1)	Ranking of concepts in order of preference(2) Concept No. 1	2	3	4	5
12. Impact on Groundwater Recharge	3.6	4	3	5	2	1
13. Impact on Fish and Wildlife	3.0	4	2	5	1	3
Socio-economic Factors						
14. Compatibility with State, Regional and Local Land Use and Development Plans	3.4	2	3	1	4	5
15. Effect on Employment and Income	4.9	1	4	2	5	3
16. Impact on Agriculture, Forestry and Commercial Fishing	5.5	3	3	3	2	1
17. Opportunities for Recreation and Tourism	4.4					
18. Potential for Local Autonomy	5.6	3	2	4	1	5
19. Costs to Local Communities	4.3	1	4	2	5	3
Public Health Factors						
20. Protection of Water Supplies	1.8	1	2	4	3	5
21. Effect on Noise Levels	5.3	1	1	1	1	1
22. Impact on Air Quality	3.8	1	1	1	1	1
Design Factors						
23. Visual, Cultural and Design Impacts	4.8	3	1	4	1	4
WEIGHED TOTALS						
Engineering Factors (1-9)		64	91	108	91	134
Environmental Factors (10-23)		129	131	154	126	154
TOTAL		193	222	262	217	288
RANK		1	3	4	2	5

1. Lower ranking shows higher significance.
2. A ranking of one represents highest preference.

Elimination of Concepts 3 and 5

As a result of the evaluation performed by the Technical Subcommittee, and in consideration of the concerns of the general public, it was decided that Concepts 3 and 5 should be eliminated from further consideration.

Concept 3. Concept 3 was determined to be deleterious to river flows in that all wastewaters from the service area would be conveyed out of the inland areas of the drainage basins to the ultimate disposal in the Boston Harbor area via the Deer and Nut Island treatment plants.

Concept 3 was furthermore determined to be incompatible with local plans, particularly in relation to the ongoing plans of the nine communities in the southwest sector of the study area.

Five communities in this area currently provide some degree of sewer service. They are Milford, Franklin, Medfield, Medway and Millis.

These communities are expected to continue providing sewer service which will be expanded in some cases to form regionalized systems.

The Town of Milford is expected to retain its municipal plant by upgrading it to produce a higher quality effluent.

The Towns of Holliston, Medway, Franklin, Wrentham and the northern part of Bellingham are expected to join the Charles River Pollution Control District which currently consists of Franklin and Medway. A second regional district is expected to be developed to meet the needs of Millis and Medfield.

The southern part of Bellingham, because of its geographical location, is better served by discharging its wastewaters into the Blackstone drainage basin.

The Town of Norfolk is not expected to require sewer service until after the year 2000. To minimize internal pumping requirements the western part of Norfolk is expected to join the Charles River Pollution Control District and the eastern part of Norfolk would join the Medfield-Millis regional system.

It was also felt that Concept 3 could not be implemented in time to satisfy the immediate needs of the upper Charles River area. Although this concept was found to be cost effective, this was only in terms of wastewater disposal and did not include water replacement considerations.

Concept 5. As in the case of Concept 3, Concept 5 was found to be deleterious to river flows in that the nature of its configuration will not provide flows at locations needing augmentation.

Concept 5 also proved to be unacceptable to the communities outside of the EMMA area with suitable land application sites to which the secondarily treated effluent was to be piped for disposal by either spray irrigation or rapid infiltration techniques as discussed in Technical Data Vol. 5.

Furthermore, the state-of-the-art for disposal of effluent on the land is relatively undeveloped, with the long term effects of such a procedure not fully understood, especially at the scale contemplated in Concept 5. For these reasons, it was felt that additional investigations are required before such a large scale system could be recommended for this area.

It must be noted here, however, that the elimination of Concept 5 from further considerations as proposed in this study is not intended to eliminate land application as a treatment technique in smaller scale systems where localized situations permit land application.

Selection of a Concept

Upon evaluation of all the factors affecting the plan selection process shown in Table 4-1, it was decided by the Technical Subcommittee that a moderately decentralized system would be the best overall solution considering river flows, increasing demand and decreasing opportunities for water-oriented activities, and the difficulties associated with extensive interceptor construction through urban areas and the filling of Boston Harbor.

Considerable concern had been expressed at the public meetings about the need for additional flow in various rivers, notably the Aberjona, Sudbury, Neponset, and Charles. Of greatest concern was the potential for serious flow problems in the Charles River as presented by the Geological Survey (GS) in the Southeastern New England Study (SENE)

conducted by the New England River Basins Commission*. The study concludes that a threat of zero flow exists in the Charles River during a number of days each year if the present practice of water withdrawal and diversion to the Harbor is continued to meet future needs. Also, an earlier study** found that development of low flow augmentation reservoirs on the Charles River is not feasible.

Past studies for other river basins also indicated problems of low flow. For example in the Neponset River basin a study in 1969*** identified the need for improving low flow conditions in addition to pollution abatement as a prerequisite for enhancing recreational needs. Following the above study, an inventory of potential reservoir sites was conducted in the Neponset River basin****. Of the 50 potential sites identified, only 9 would yield an average flow over one million gallons per day (mgd) and the largest would yield an average of 3.6 mgd. It appears that an average of about five mgd could be developed. However, such developments would require displacement of houses, roads and industry.

In addition to river flows, concerns expressed at public meetings centered around Harbor filling required to provide secondary treatment, the environmental and health effects of the facilities, the discharge and its impact on the beaches and the fishing industry, and the effects of construction activities on the neighborhoods surrounding the facilities.

In relation to the satellite plants, concerns were expressed over the impact of such facilities on water quality especially under low flow conditions, or property values, and on the possible loss of taxable property.

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*"Ground-Water Management, Charles River Basin, Massachusetts" Section 3.03 United States Department of the Interior Geological Survey, Open-file Report by Michael H. Frimpter, 1973.

**Department of the Army, New England Division, Corps of Engineers, Memorandum - Water Resources Development Plan, Charles River Watershed, Massachusetts, April 28, 1972.

***Report of the Metropolitan District Commission and The Department of Natural Resources Relative to the Department of Natural Resources Carrying Out Certain Water Management Projects on The Neponset River and Acquiring Certain Lands Adjacent to the River for Conservation and Recreation Purposes, The Commonwealth of Massachusetts, House No. 4940, December 1969.

****Inventory of Potential Upstream Reservoir Sites - Neponset Study Area, Massachusetts. U.S. Department of Agriculture, Soil Conservation Service, October 1970.

The decentralized concept selected was as follows:

1. Development of treatment plants in the Upper Charles River basin in accordance with on-going activities, namely, plants in Medfield, Medway and Milford.

2. Consideration of augmenting flows in the Aberjona River through a small (about 2 mgd) highly advanced wastewater treatment plant located there or by other means.

3. Development of satellite treatment facilities in the Neponset River basin area.

4. Development of satellite treatment facilities to generally serve the communities of the Wellesley-Framingham Interceptor system by locating discharges either to the Upper Sudbury River or the Middle Charles River.

To finalize Item 4, it was decided to quantify and evaluate several alternatives described in the next chapter.

CHAPTER 5

DEVELOPMENT AND EVALUATION OF ALTERNATIVES

General

Four satellite treatment plant alternatives were selected by the Technical Subcommittee for consideration during this evaluation. The four alternatives retain the service area for the Deer Island Treatment Plant as developed in Concept 1. Various service areas for the Nut Island Treatment Plant were then investigated and are briefly described in the following sections. Under all four of these alternatives, the flows from the remaining communities in the present Nut Island Treatment Plant service area (as shown in Table 5-1) not mentioned in the following sections, would continue to be transported to the Nut Island Plant for treatment, and effluent discharge to the Harbor.

TABLE 5-1. NUT ISLAND TREATMENT PLANT
PRESENT SERVICE AREA COMMUNITIES

Community name	
Ashland	Stoughton
Braintree	Walpole
Brookline (part)	Wellesley
Canton	Westwood
Dedham	Weymouth
Framingham	Boston
Hingham	Dorchester
Holbrook(1)	FNWY-JMACA
Milton (part)	Hyde Park
Natick	Mattapan(2)
Needham	Roslindale(2)
Newton (part)	West Roxbury
Norwood	
Quincy	
Randolph	

1. Presently not contributing flow to the MDC.
2. Negligible areas of Mattapan and Roslindale that contribute to the Deer Island Treatment Plant are considered tributary to the Nut Island Treatment Plant.

Alternative A

Alternative A shown in Figure 5-1, consists of a plant discharging to the Middle Charles River (Wellesley-Dover-Needham) and a plant discharging to the lower Neponset River (Dedham-Canton).

Middle Charles River Plant (Wellesley-Dover-Needham-Natick Area) to serve Hopkinton, Southborough, Ashland, Framingham, Natick, part of Wellesley, and after the year 2000, Sherborn and part of Dover. Plant data is as follows:

Size	= 31 mgd
Capital cost	= $49.6 million
Annual O&M cost	= $ 3.1 million

Lower Neponset River Plant (Dedham-Canton Area) to serve Stoughton, Sharon, Walpole, Norwood, Westwood and Canton. Plant data is as follows:

Size	= 31 mgd
Capital cost	= $49.6 million
Annual O&M cost	= $ 3.1 million

Alternative B

Alternative B, shown in Figure 5-2, includes a larger plant discharging to the lower middle Charles River (Dedham-Boston) and a plant discharging to the lower Neponset River as in Alternative A.

Lower Middle Charles River Plant (Dedham-Boston Area) to serve Southborough, Hopkinton, Ashland, Framingham, Natick, Needham, parts of Wellesley, Dedham, Newton, Brookline, and after the year 2000, Sherborn and Dover. Plant data is as follows:

Size	= 57 mgd
Capital cost	= $81.0 million
Annual O&M cost	= $ 5.3 million

Lower Neponset River Plant to serve the same communities as outlined in Alternative A.

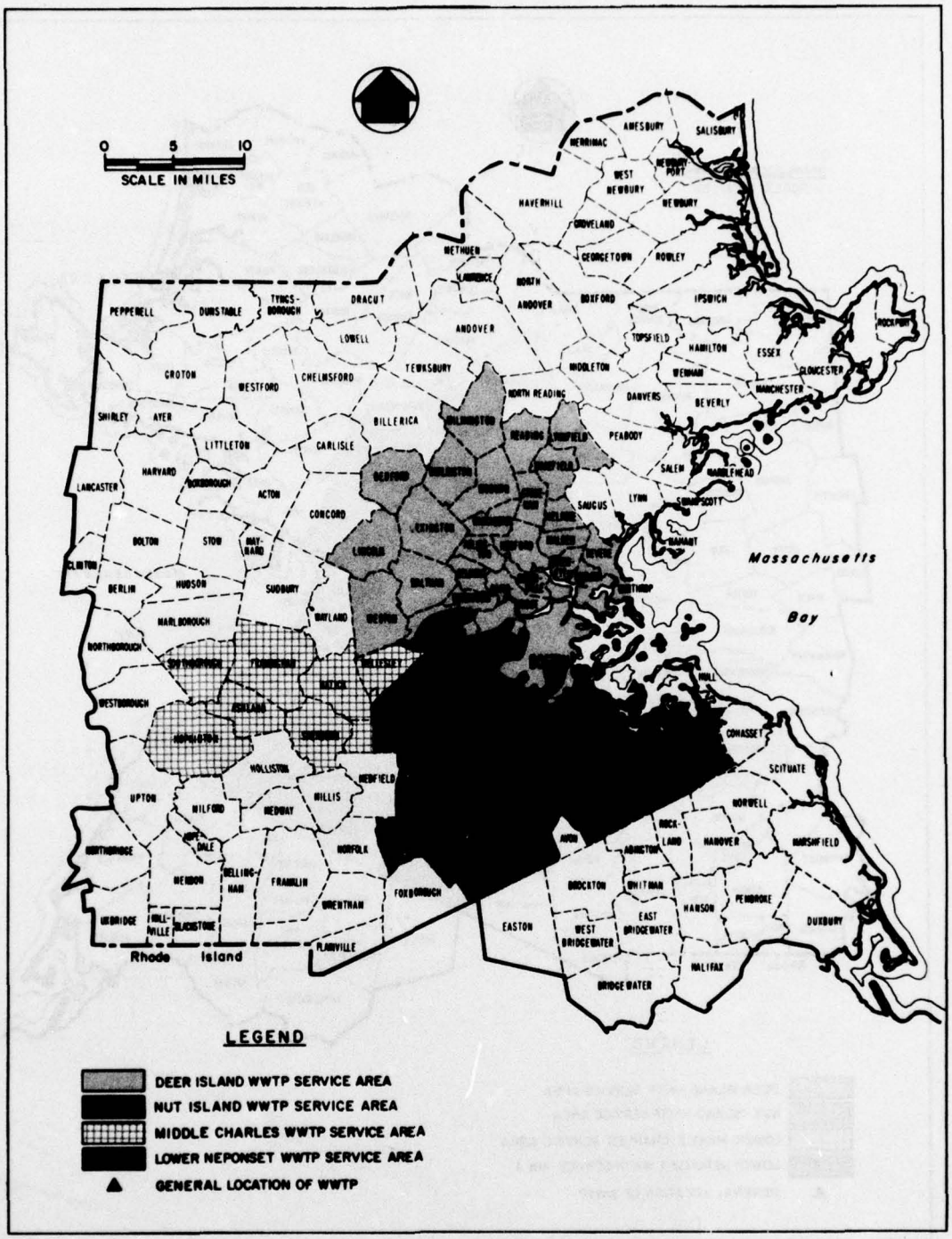


FIG. 5-1 ALTERNATIVE A

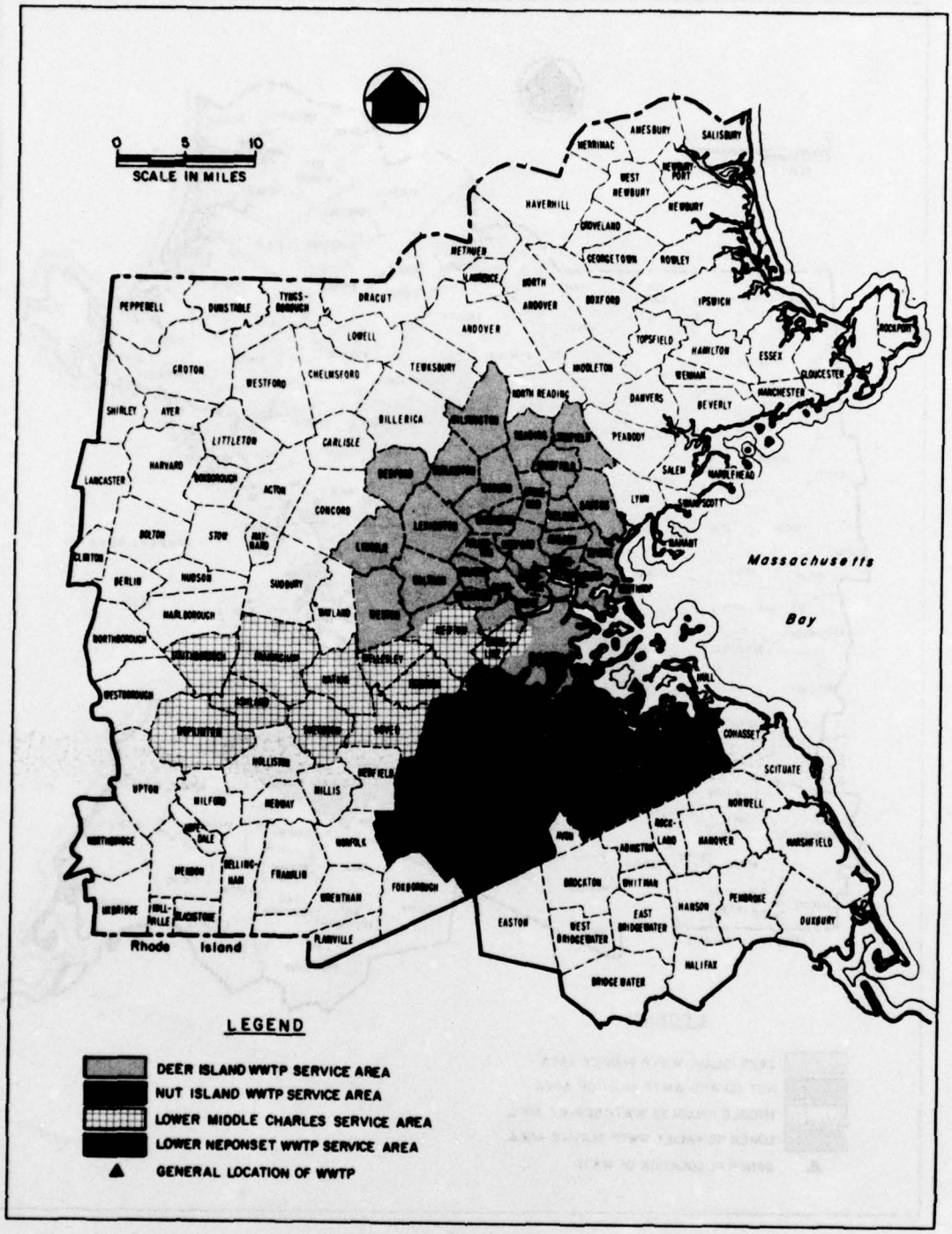


FIG. 5-2 ALTERNATIVE B

Alternative C

Alternative C is shown in Figure 5-3 and includes three satellite plants. One would be in the middle Charles River area as in Alternative A. A second plant would discharge to the lower middle Charles River area, with the third plant discharging to the lower Neponset River area.

Middle Charles River Plant to serve the same communities as outlined in Alternative A.

Lower Middle Charles River Plant to serve Needham, and parts of Dedham, Newton and Brookline and after the year 2000, part of Dover. Plant data is as follows:

Size	= 27 mgd
Capital cost	= $46.0 million
Annual O&M cost	= $ 2.8 million

Lower Neponset River Plant to serve the same communities as outlined in Alternative A.

Alternative D

Alternative D, shown in Figure 5-4, provides for three plants, each discharging into a separate river. One would discharge to the Upper Sudbury River (Framingham area), another to the lower middle Charles River area, and the third to the lower Neponset River area.

Upper Sudbury River Plant (Framingham Area) to serve Southborough, Hopkinton, Ashland and Framingham with discharge to the Sudbury River. Plant data is as follows:

Size	= 19 mgd
Capital cost	= $35.0 million
Annual O&M cost	= $ 2.1 million

Lower Middle Charles River Plant to serve Natick, Needham, and part of Wellesley, Newton, Brookline, and Dedham, and after the year 2000, Sherborn and Dover. Plant data is as follows:

Size	= 39 mgd
Capital cost	= $61.0 million
Annual O&M cost	= $ 3.8 million

FIG. 5-3 ALTERNATIVE C

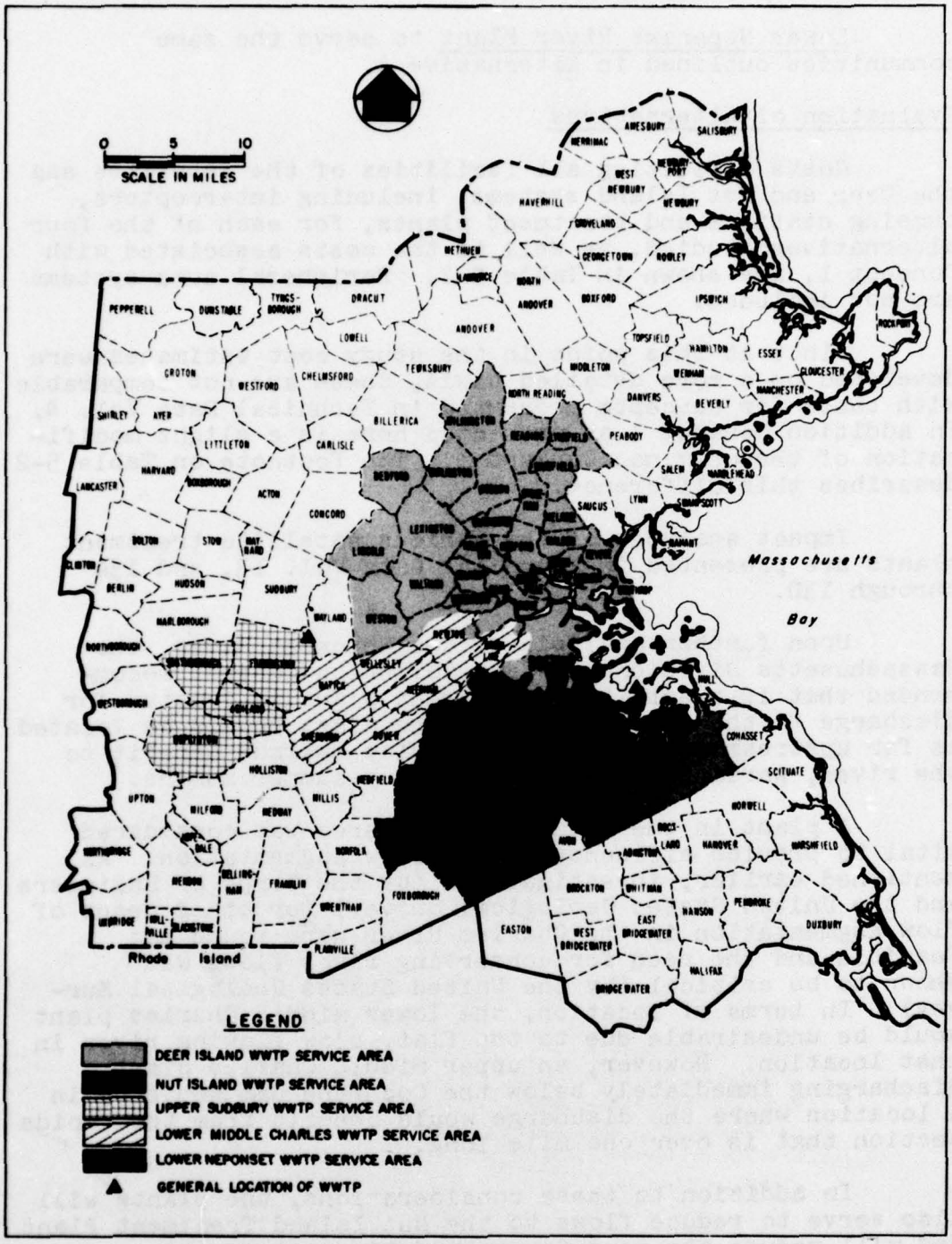


FIG. 5-4 ALTERNATIVE D

Lower Neponset River Plant to serve the same communities outlined in Alternative A.

Evaluation of Alternatives

Costs reflecting all facilities of the satellite and the Deer and Nut Island systems, including interceptors, pumping stations and treatment plants, for each of the four alternatives studied, as well as the costs associated with Concept 1, are shown in Table 5-2. Peripheral area systems are not included.

Since at this point in the study cost estimates were developed on a more detailed basis, these are not comparable with costs for concepts presented in Technical Data Vol. 4. In addition Concept 1 as presented here is a slight modification of the original Concept 1. The footnote on Table 5-2 describes this difference.

Impact analyses of the various satellite treatment plants are presented in Technical Data Vol. 13, and 13A through 13D.

Upon further analysis of the Neponset River, the Massachusetts Division of Water Pollution Control recommended that if a satellite treatment plant is located for discharge to the Neponset River, the plant should be located as far upstream as possible to provide maximum benefit to the river, particularly during the dry summer months.

A plant in the middle Charles area was considered vital to provide effluent for low flow augmentation. As mentioned earlier, investigations (by the Corps of Engineers and the United States Geological Survey) for other means of flow augmentation in the Charles River were found not feasible and the need for conserving river flows was shown to be critical (by the United States Geological Survey). In terms of location, the lower middle Charles plant would be undesirable due to the flat, slow flowing river in that location. However, an upper middle Charles plant discharging immediately below the Cochrane Dam would be in a location where the discharge would benefit from the rapids section that is over one mile long.

In addition to these considerations, the plants will also serve to reduce flows to the Nut Island Treatment Plant and will reduce the need for relief lines along the Wellesley Extension Sewer, the New Neponset Valley Sewer, and the High Level Sewer.

TABLE 5-2. COST COMPARISON OF ALTERNATIVES

System	Capital cost, (millions $) Concept 1[1]	Alt. A	Alt. B	Alt. C.	Alt. D
Deer and Nut Island WWTP Service area improvements					
1. Deer Island WWTP	192	192	192	192	192
2. Nut Island WWTP	169	127	100	100	100
3. Deer and Nut Island sludge management	58	52	50	50	50
4. Interceptors and P.S.	196	85	75	75	75
Subtotal	615	456	417	417	417
Local share	61.5	45.6	41.7	41.7	41.7
Satellite area systems					
1. Upper Charles WWTP's and interceptors	47	47	47	47	47
2. Other satellite WWTP's	0	99	131	145	146
3. Other satellite interceptors and pumping stations	0	55	79	64	52
Subtotal	47	201	257	256	245
Local share	4.7	20.1	25.7	25.6	24.5
Grand total					
Complete cost	662	657	674	673	662
Local share	66.2	65.7	67.4	67.3	66.2
	Operation and maintenance costs, (millions $ per year)				
Deer and Nut Island WWTP's (including sludge mgnt)	16	15	14	14	14
Upper Charles WWTP's	2	2	2	2	2
Other Satellite WWTP's	0	6	8	9	9
Total annual O&M cost	18	23	24	25	25

1. Concept 1 with Marlborough Easterly alone and Southborough to Nut Island.

Providing a 2 mgd wastewater treatment plant in the Aberjona River area would cost on the order of 9.7 million dollars to construct and about 0.7 million dollars per year to operate. These costs represent treatment processes presented on Figure 7-4 of Technical Data Vol. 2. On the basis of operating costs alone, this would be in excess of three times the cost of using MDC water for augmentation. In addition to this, other alternatives of flow augmentation should be considered such as groundwater pumping during low flows and recharge during high flows.

A wastewater treatment plant discharging to the Sudbury River in the Framingham area was considered as not providing a significant improvement in flows due to the large storage potential in the flat swampy areas downstream. In addition, opportunities for low flow regulation exist at MDC reservoirs and groundwater recharge opportunities exist by regulation of the existing dams.

Comparative stream flow data pertinent to the rivers receiving the discharge from the satellite treatment plants is presented in Table 5-3.

TABLE 5-3. APPROXIMATE STREAM FLOW COMPARISON[1]

Recommended advanced wastewater treatment facility location	Average discharge (mgd) (year 2000)	Receiving stream	Upstream effluent discharge (mgd)	10 yr-7 day low flow (mgd)	July through October average flow (mgd)	Annual average flow (mgd)	100 yr flood flow (mgd)
Upper Aberjona	2	Aberjona River	0	0.25	5	18	790
Upper Neponset	25	Neponset River	0	36	35	80	1,400
Middle Charles	31	Charles River	16	7	80	195	2,650
Upper Sudbury	19	Sudbury River	0	1.5[2]	11	75	3,250

1. Values are approximate estimates and are meant for order-of-magnitude comparisons only.
2. Discharge from Sudbury Reservoir regulated by statute.

CHAPTER 6

THE RECOMMENDED PLAN

General

The Recommended Plan was selected by the Technical Subcommittee in accordance with the following conclusions:

1. A plant discharging to the middle Charles River area would be of major benefit in maintaining river flows. However, such discharge should be in the upper section at Cochrane Dam to obtain maximum benefit from the physical characteristics of the river.

2. The location of a discharge on the Neponset River should be as far upstream as possible to provide the maximum benefit to the river, particularly during the dry summer months.

3. While flow augmentation in the Sudbury River may be beneficial, discharge from a treatment plant in the Framingham area would be of limited value due to the river's wide, flat configuration and adjacent marshlands.

4. A small treatment plant on the Aberjona River does not appear to be a cost-effective method of low flow augmentation. A number of other flow augmentation alternatives are available and should be investigated first.

Description of Recommended Plan

As shown in Figure 6-1, the service area of the Deer Island Treatment Plant would be enlarged by three communities, the service area of the Nut Island Treatment Plant would be reduced, and the outer area in the southwestern part of the Metropolitan Sewerage District would be provided with wastewater treatment facilities in the upper Neponset River and the middle Charles River areas. The Recommended Plan encompasses 51 communities, eight more than are presently MSD members, and is discussed in detail in Technical Data Vol. 15.

The recommendations are based upon providing secondary treatment at the coastal plants and advanced treatment at the inland plants. Toxic substances in industrial wastes would be subject to EPA pretreatment regulations prior to discharge into sewer systems.

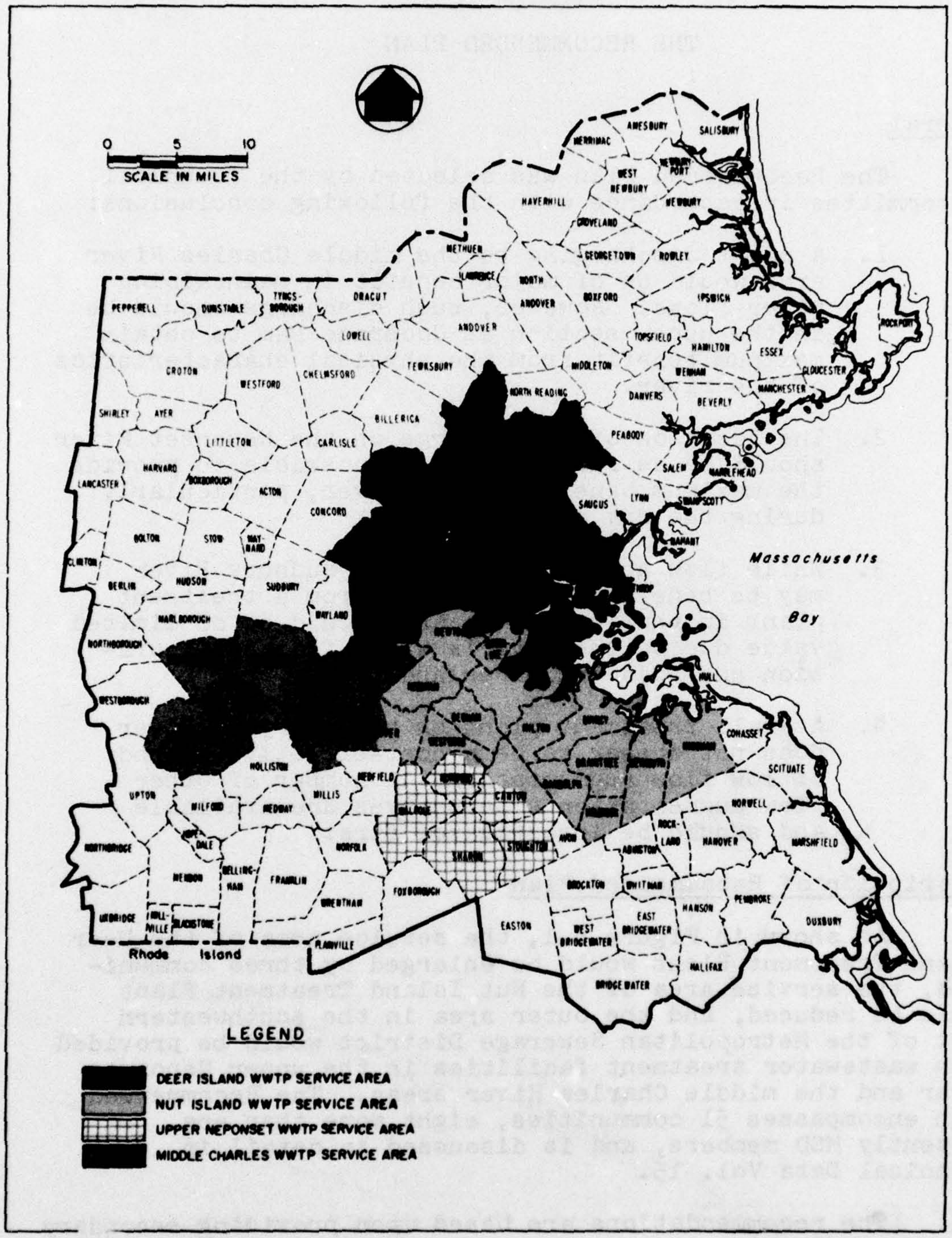


FIG. 6-1 WASTEWATER TREATMENT PLANT SERVICE AREAS–RECOMMENDED PLAN

Boston Harbor. The present primary treatment plant at Deer Island would be expanded, upgraded and extended to a secondary treatment facility handling anticipated average flows of 400 mgd in the year 2000. Details on this are presented in Technical Data Vol. 10. The Nut Island primary treatment plant would also be expanded, upgraded and extended to secondary treatment in order to handle an anticipated average flow of 130 mgd in the year 2000. Details on this plant are presented in Technical Data Vol. 11. The two plants are currently designed for 343 mgd (Deer Island) and 112 mgd (Nut Island). Site options for these expansions were investigated and site layouts were selected for cost estimating purposes subject to detailed engineering and environmental analyses. The sludge produced at these facilities would be incinerated rather than discharged into the Harbor in accordance with a plan selected by the MDC from another study*. These improvements will benefit overall water quality, help safeguard public health, and enhance water-oriented recreation. It should be noted, however, that the restoration of Boston Harbor water quality will also depend upon abating several other causes of pollution, notably combined sewer overflows. Recommendations for the regulation of these are presented in Technical Data Vol. 7.

Neponset River. An advanced wastewater treatment facility would be located in the Canton-Norwood area. It would treat approximately 25 mgd in the year 2000 from the towns of Canton, Norwood, Walpole, Sharon and Stoughton. This facility would reduce the service area of the Nut Island Treatment Plant and keep reclaimed wastewater as far upstream in the Neponset River Basin as possible. The highly treated effluent should help the Neponset River by improving flows in dry summer months.

Charles River. The middle reach of the Charles River would be the location for an advanced wastewater treatment facility to serve the towns of Wellesley, Framingham, Ashland, Hopkinton, Natick and Southborough as well as Sherborn and part of Dover when local sewerage systems are provided there. This 31-mgd facility would reduce flows to the Nut Island Plant and help retain reclaimed wastewater in the Charles River Basin.

*A Plan for Sludge Management, prepared for the Commonwealth of Massachusetts Metropolitan District Commission, by Havens and Emerson Consulting Engineers, June 1973.

Aberjona River. An advanced wastewater treatment facility of about 2 mgd in the Woburn area would be under consideration as an alternative to serve the special purpose of augmenting flows in the Aberjona River during summer months. Other means of providing low flow augmentation should be evaluated first to determine which is the most cost effective solution. On this basis and because such a small flow reduction would not change the system downstream from this possible plant, the plans and projects evaluated hereinafter in this report do not include considerations of the construction of a treatment plant on the Aberjona River.

Recommended Facilities

The projects under the recommended plan are shown on Figure 4-2 in Technical Data Vol. 15. These projects are shown in accordance with the new sequence numbers.

Figure 6-2 lists the recommended projects along with their cost and anticipated time schedule for completion. This schedule represents the final negotiated (new) sequence of projects following an earlier construction schedule selected by the Technical Subcommittee and presented in Chapter 7 as a construction staging alternative entitled Postponement of Secondary Treatment. The diagram also presents the scheduling of each of 52 projects showing the three steps of implementation, namely:

Step 1 - Facilities Planning

Step 2 - Preparation of Construction Drawings and Specifications

Step 3 - Construction

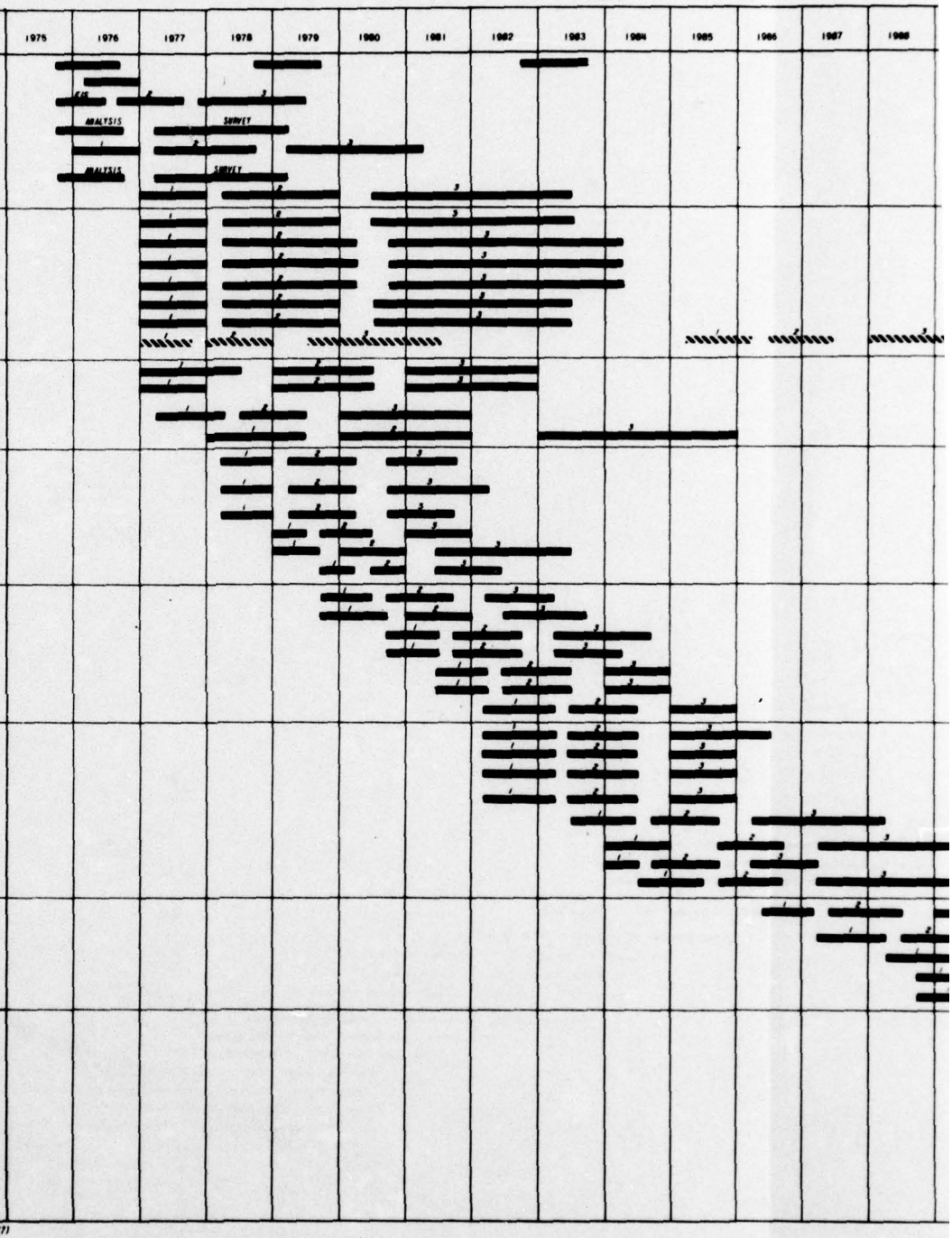
Each of the facilities built is expected to be in operation at the end of Step 3.

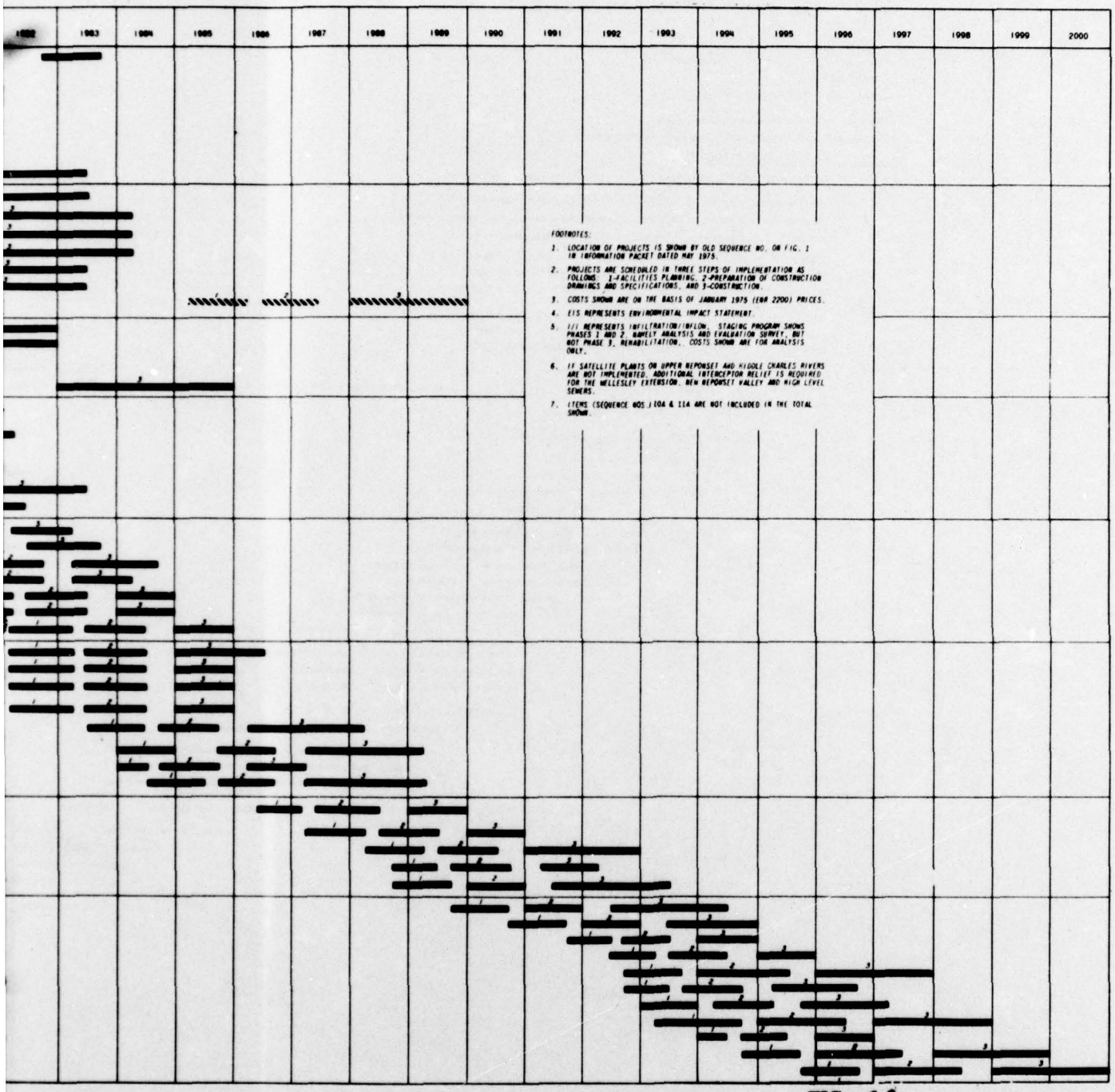
In addition, three anticipated requests for authorization and funding by the Massachusetts Legislature are shown.

Details regarding each project are presented in the appropriate technical data volumes listed on the inside cover.

1

SEQUENCE NO. NEW	SEQUENCE NO. OLD[1]	DESCRIPTION[2]	SEWER SECTION NO.	COST $ [3]
		AUTHORIZATION BY LEGISLATURE		
		EIS OR MAJOR STUDY PROJECTS[4]		
1	1	SLUDGE MANAGEMENT (PRIMARY)		25,573,000
2	2	I/I ANALYSIS (SOUTH SYSTEM)[5]		983,500
3	14	DORCHESTER BAY COMB. S. OVERFLOWS		77,000,000
4	15	I/I ANALYSIS (NORTH SYSTEM)[5]		1,012,000
5	5 & 6	N.I. PRIMARY EXT. (INCL. OUTFALL)		50,536,000
6	33	D.I. PRIMARY EXP.		41,900,000
7	42	N.I. SECONDARY EXT.		86,700,000
8	43	D.I. SECONDARY EXT.		150,000,000
9	44	SLUDGE MANAGEMENT (SECONDARY)		28,094,000
10	9	MIDDLE CHARLES R. W.W.T.P.		49,600,000
11	4	UPPER NEPONSET R. W.W.T.P.		41,100,000
10A & 11A	-	(INTERCEPTOR RELIEF TO LIEU OF (SEQUENCE NOS.) 10 & 11)[6]		68,700,000
12	28	CHARLES R. COMB. S. OVERFLOWS		84,000,000
13	27	NEPONSET R. COMB. S. OVERFLOWS		23,000,000
14	7	FRAMINGHAM EXT. S.	134, 133B, 132	22,461,000
15	53	LOWER HARBOR COMB. S. OVERFLOWS		86,000,000
16	8	LOWER BRAINTREE COMB. S.	125 BRANCH	400,000
17	9	BRAINTREE WEYMOUTH P.S.		2,920,000
18	10	WINCHAM F.M.		534,000
19	11	STOUGHTON EXT. S.	115, 119, 121	1,090,000
20	12	WALPOLE EXT. S.	116, 117, 118	11,894,000
21	13	NO. CHARLES METRO. S.	63	1,271,000
22	16	MILLBROOK VALLEY S.	84, 85	3,771,000
23	17	QUINCY P.S. & F.M.		2,220,000
24	18	NORTH METRO. S.	17	1,165,000
25	19	CHELSEA BRANCH S.	51	145,000
26	20	STONEHAM EXT. S.	51	348,900
27	21	STONEHAM TRUNK S.	42	145,000
28	22	EAST BOSTON STEAM P.S.		1,460,000
29	23	CHARLESTOWN P.S.		6,000,000
30	24	ALEWIFE BROOK P.S.		712,000
31	25	EAST BOSTON ELECTRIC P.S.		965,000
32	26	HOWARD BECK P.S.		209,000
33	29	SOMERVILLE MEDFORD BRANCH S.	35	4,500,000
34	30	SOUTH CHARLES REL. S.	4A, 4-A	2,670,000
35	31	WAKEFIELD BRANCH S.	50-60, 60-49, 50-49	838,000
36	32	SOUTH CHARLES RIVER S.	5-A, 5-B	8,428,000
37	34	CUMMINGSVILLE BRANCH S.	47-06	1,012,000
38	35	HINGHAM P.S.		890,000
39	36	REVERE EXT. S.	57A, 62	3,413,000
40	37	LYNNFIELD EXT. S.		967,000
41	38	ASHLAND-HOPKINTON EXT. S.		4,459,000
42	39	WESTON-LINCOLN EXT. S.		1,832,000
43	40	SOUTHBORO EXT. S.		2,421,000
44	41	SHARON EXT. S.		218,000
45	45	STOUGHTON EXT. S.	119, 120, 121	827,000
46	46	WILMINGTON EXT. S.	89, 90	2,964,000
47	47	NORTH METRO S.	66.5, 67, 112	475,000
48	48	WESTWOOD EXT. S.	136, 138	2,990,000
49	49	WAKEFIELD TRUNK S.	50-61, 50-61, 87-60	4,756,000
50	50	WAKEFIELD BRANCH S.	50-60	177,000
51	51	SO. CHARLES RELIEF S.	6-A, 6-G, 6-F, 5-F, 5-E	2,011,000
52	52	SO. CHARLES RIVER S.	5-C	4,200,000
		TOTAL (INITIAL ISSUE AUGUST 20, 1975)		866,980,000[7]





FOOTNOTES:

1. LOCATION OF PROJECTS IS SHOWN BY OLD SEQUENCE NO. ON FIG. 1 IN INFORMATION PACKET DATED MAY 1975.
2. PROJECTS ARE SCHEDULED IN THREE STEPS OF IMPLEMENTATION AS FOLLOWS: 1-FACILITIES PLANNING, 2-PREPARATION OF CONSTRUCTION DRAWINGS AND SPECIFICATIONS, AND 3-CONSTRUCTION.
3. COSTS SHOWN ARE ON THE BASIS OF JANUARY 1975 (ENR 2200) PRICES.
4. EIS REPRESENTS ENVIRONMENTAL IMPACT STATEMENT.
5. I/I REPRESENTS INFILTRATION/INFLOW. STAGING PROGRAM SHOWS PHASES 1 AND 2, NAMELY ANALYSIS AND EVALUATION SURVEY, BUT NOT PHASE 3, REHABILITATION. COSTS SHOWN ARE FOR ANALYSIS ONLY.
6. IF SATELLITE PLANTS ON UPPER NEPONSET AND MIDDLE CHARLES RIVERS ARE NOT IMPLEMENTED, ADDITIONAL INTERCEPTOR RELIEF IS REQUIRED FOR THE WELLESLEY EXTENSION, NEW NEPONSET VALLEY AND HIGH LEVEL SEWERS.
7. ITEMS (SEQUENCE NOS.) 10A & 11A ARE NOT INCLUDED IN THE TOTAL SHOWN.

FIG 6-2
MDC CONSTRUCTION STAGING PROGRAM
FOR WASTEWATER MANAGEMENT
RECOMMENDED PLAN

CHAPTER 7

CONSTRUCTION STAGING ALTERNATIVES

General

Prior to arriving at the project sequence presented in Chapter 6, two other alternatives were considered in carrying out the recommended plan. These two alternatives which relate to the timing of construction for the satellite treatment facilities and the extension to secondary treatment capabilities at the Harbor plants are discussed in the following paragraphs.

Several factors played a major role in the development of the sequence of construction alternatives. One is the physical needs of systems to handle wastewaters adequately. The second is the relative water quality objectives achieved in the EMMA area per dollar expended. The third is a recognition that all funds or approvals needed to implement the entire program may not be available in the time needed.

Six priority categories were established. These contain treatment plants, interceptor and pumping station relief or upgrading, together with water pollution control facilities, interceptors and pumping stations that are to be added to adequately handle the projected flows and pollutants from the service area.

Postponement of Satellite Plants and Secondary Treatment

This alternative is the postponement of secondary treatment at the Deer and Nut Island treatment plants and the postponement of satellite plants on the Middle Charles River and the Upper Neponset River.

Table 7-1 shows the proposed sequence of projects under this alternative, along with the sequence number of the recommended construction staging program. Table 7-2 shows the funding requirements for each priority group.

Priority 1 Projects. Major items included under Priority 1 are infiltration/inflow analysis of the South System (sewers draining to the Nut Island and the proposed satellite treatment plants on the Charles and Neponset rivers); construction of sludge management facilities to serve Deer and Nut Island treatment plants; expansion of primary treatment facilities at Nut Island; and construction of facilities pertaining to the abatement of combined sewer

TABLE 7-1. ALTERNATIVE CONSTRUCTION STAGING PROGRAM WHERE SATELLITE PLANTS AND SECONDARY TREATMENT ARE POSTPONED

Sequence No.		Priority		Sewer
Alternative	New(1)	No.	Description	section No.
1	1	1	Sludge management (primary)	
2	2	1	I/I analysis (South System)	
3		1	Wellesley Ext. S.	106,105, 104,103, 102,101, 100,99,98
4	5	1	N.I. Primary Exp.	
5	5	1	N.I. Outfall	
6	14	1	Framingham Ext. S.	134,133B, 132
7	16	1	Lower Braintree Conn. S.	125 branch
8	17	1	Braintree-Weymouth P.S.	
9	18	1	Hingham F.M.	
10		1	New Neponset Valley S.	111,112, 113,114, 115
11	19	1	Stoughton Ext. S.	119,121
12	20	1	Walpole Ext. S.	116,117 118
13	21	1	No. Charles Metro. S.	63
14	3	1	Dorchester Bay Comb. S. Overflows	

TABLE 7-1 (Continued). ALTERNATIVE CONSTRUCTION STAGING PROGRAM WHERE SATELLITE PLANTS AND SECONDARY TREATMENT ARE POSTPONED

Sequence No.		Priority		Sewer
Alternative	New(1)	No.	Description	section No.
15	4	2	I/I Analysis (North System)	
16	22	2	Millbrook Valley S.	84,85
17	23	2	Quincy, P.S. and F.M.	
18	24	2	North Metro. S.	17
19	25	2	Chelsea Branch S.	57
20	26	2	Stoneham Ext. S.	51
21	27	2	Stoneham Trunk S.	42
22	28	2	East Boston Steam P.S.	
23	29	2	Charlestown P.S.	
24	30	2	Alewife Brook P.S.	
25	31	2	East Boston Electric P.S.	
26		2	New Neponset Valley S.	107,108, 109,110
27	32	2	Houghs Neck P.S.	
28	13	2	Neponset R. Comb. S. Overflows	
29	12	2	Charles R. Comb. S. Overflows	

TABLE 7-1 (Continued). ALTERNATIVE CONSTRUCTION STAGING PROGRAM WHERE SATELLITE PLANTS AND SECONDARY TREATMENT ARE POSTPONED

Sequence No.		Priority		Sewer
Alternative	New(1)	No.	Description	section No.
30	33	3	Somerville-Medford Branch S.	35
31	34	3	South Charles Rel. S.	4A,4H
32	35	3	Wakefield Branch S.	50-60,60-49,59-49
33	36	3	South Charles River S.	5A,5B
34	6	3	D.I. Primary Exp.	
35	37	4	Cummingville Branch S.	47-86
36	38	4	Hingham P.S.	
37	39	4	Revere Ext. S.	57A,62
38	40	4	Lynnfield Ext. S.	
39	10	4	Middle Charles R. Treatment Plant	
40	11	4	Upper Neponset R. Treatment Plant	
41	41	4	Ashland-Hopkinton Ext. S.	
42	42	4	Weston-Lincoln Ext. S.	
43	43	4	Southboro Ext. S.	

TABLE 7-1 (Continued). ALTERNATIVE CONSTRUCTION STAGING PROGRAM WHERE SATELLITE PLANTS AND SECONDARY TREATMENT ARE POSTPONED

Sequence No.		Priority		Sewer
Alternative	New(1)	No.	Description	section No.
44	44	4	Sharon Ext. S.	
45	7	5	N.I. Secondary Ext.	
46	8	5	D.I. Secondary Ext.	
47	9	5	Sludge Management (Secondary)	
48	45	5	Stoughton Ext. S.	119,120, 121
49	46	5	Wilmington Ext. S.	89,90
50	47	5	North Metro. S.	44.5,67, 112
51	48	5	Westwood Ext. S.	135,136
52	49	5	Wakefield Trunk S.	59-41,58-41,87-40
53	50	5	Wakefield Branch S.	50-60
54	51	5	So. Charles Relief S.	4H,4G,4F, 3E,3F
55	52	5	So. Charles River S.	5C
56	15	6	Inner Harbor Comb. S. Overflows	

1. Acceptable to EPA.

TABLE 7-2. FUNDING REQUIREMENTS FOR ALTERNATIVE CONSTRUCTION STAGING PROGRAM WHERE SATELLITE PLANTS AND SECONDARY TREATMENT ARE PROPOSED

Priority No.	Total cost, $
On-going	$ 21,184,000
1	233,237,000(1)
2	132,350,000
3	48,436,000
4	116,538,000
5	286,689,000
6	86,000,000
Total	$924,434,000(2)

1. Add $5,440,000 to cover primary tanks at Nut Island.
2. Does not include Localized Remedial Measures for Combined Sewers (approximately $13,000,000) which should be carried out throughout the project.

overflows in the Dorchester Bay area where most of the downtown beaches are located. The interceptors included under Priority 1 are those currently taxed to their capacity or expected to reach capacity in the near future.

Priority 2 Projects. Major items included as Priority 2 Projects include the infiltration/inflow analysis for the North System (sewers draining to the Deer Island treatment plant); upgrading of several major pumping stations; and abatement of combined sewer overflows in the Neponset and Charles River areas. Interceptors included as part of Priority 2 work will require relief as the service expands in terms of population and sewered acres.

Priority 3 Projects. The major item included in Priority 3 is the expansion of primary treatment facilities at the Deer Island Treatment Plant. Interceptors included in this category are those projected to be inadequate in the future.

Priority 4 Projects. The major items included in Priority 4 are the construction of two new satellite treatment plants on the Charles and Neponset rivers. Numerous interceptor facilities are included in the Priority 4 grouping consisting of relief lines, and new lines to sewer additional communities. Additional communities that are expected to be added and require new extensions are Hopkinton, Southborough, Lynnfield, Weston, Lincoln and Sharon. These have been included in Priority 4 because they are not currently contributing flow to the MDC system.

Priority 5 Projects. The major items included in the Priority 5 work program include the addition of secondary treatment capabilities at the Deer and Nut Island treatment plants and expansion of sludge management facilities associated with these additions. The interceptors associated with the Priority 5 work program are the last of those expected to require relief during the time frame relating to this study.

Priority 6 Projects. The item listed as Priority 6 in the construction staging program relates to the abatement of pollution from Inner Harbor combined sewer overflows.

Postponement of Secondary Treatment

This alternative consists of the postponement of providing secondary treatment at the Deer and Nut Island treatment plants until a later date after most of the combined sewer overflow projects are completed.

Table 7-3 shows the proposed sequence of projects under this alternative and Table 7-4 shows the funding requirements for each priority group.

Priority 1 Projects. Major items included under Priority 1 are infiltration/inflow analysis of the South System; construction of sludge management facilities to serve Deer and Nut Island treatment plants; construction of new satellite treatment plants on the Charles and Neponset rivers; expansion of primary treatment facilities at Nut Island; and construction of facilities pertaining to the abatement of combined sewer overflows in the Dorchester Bay area where most of the downtown beaches are located.

TABLE 7-3. ALTERNATIVE CONSTRUCTION STAGING PROGRAM WHERE SECONDARY TREATMENT IS POSTPONED

Sequence No. Alternative	Sequence No. New(1)	Priority No.	Description	Sewer section No.
1	1	1	Sludge Management	
2	2	1	I/I Analysis (South System)	
3	10	1	Middle Charles R. Treatment Plant	
4	11	1	Upper Neponset R. Treatment Plant	
5	5	1	N.I. Primary Exp.	
6	5	1	N.I. Outfall	
7	14	1	Framingham Ext. S.	134,133B, 132
8	16	1	Lower Braintree Conn. S.	125 branch
9	17	1	Braintree-Weymouth P.S.	
10	18	1	Hingham F.M.	
11	19	1	Stoughton Ext. S.	119,121
12	20	1	Walpole Ext. S.	116,117, 118
13	21	1	No. Charles Metro. S.	63
14	3	1	Dorchester Bay Comb. S. Overflows	
15	4	2	I/I Analysis (North System)	

TABLE 7-3 (Continued). ALTERNATIVE CONSTRUCTION STAGING PROGRAM WHERE SECONDARY TREATMENT IS POSTPONED

Sequence No.		Priority		Sewer
Alternative	New(1)	No.	Description	section No.
16	22	2	Millbrook Valley S.	84,85
17	23	2	Quincy P.S. and F.M.	
18	24	2	North Metro. S.	17
19	25	2	Chelsea Branch S.	57
20	26	2	Stoneham Ext. S.	51
21	27	2	Stoneham Trunk S.	42
22	28	2	East Boston Steam P.S.	
23	29	2	Charlestown P.S.	
24	30	2	Alewife Brook P.S.	
25	31	2	East Boston Electric P.S.	
26	32	2	Houghs Neck P.S.	
27	13	2	Neponset R. Comb. S. Overflows	
28	12	2	Charles R. Comb. S. Overflows	
29	33	3	Somerville-Medford Branch S.	35
30	34	3	South Charles Rel. S.	4A,4H

TABLE 7-3 (Continued). ALTERNATIVE CONSTRUCTION STAGING PROGRAM WHERE SECONDARY TREATMENT IS POSTPONED

Sequence No.		Priority		Sewer
Alternative	New(1)	No.	Description	section No.
31	35	3	Wakefield Branch S.	50-60,60-49,59-49
32	36	3	South Charles River S.	5A,5B
33	6	3	D.I. Primary Exp.	
34	37	4	Cummingsville Branch S.	47-86
35	38	4	Hingham P.S.	
36	39	4	Revere Ext. S.	57A,62
37	40	4	Lynnfield Ext. S.	
38	41	4	Ashland-Hopkinton Ext. S.	
39	42	4	Weston-Lincoln Ext. S.	
40	43	4	Southborough Ext. S.	
41	44	4	Sharon Ext. S.	
42	7	5	N.I. Secondary Ext.	
43	8	5	D.I. Secondary Ext.	
44	9	5	Sludge Management (secondary)	
45	45	5	Stoughton Ext. S.	119,120,121
46	46	5	Wilmington Ext. S.	89,90

TABLE 7-3 (Continued). ALTERNATIVE CONSTRUCTION STAGING PROGRAM WHERE SECONDARY TREATMENT IS POSTPONED

Sequence No.		Priority		Sewer
Alternative	New(1)	No.	Description	section No.
47	47	5	North Metro S.	44.5,67, 112
48	48	5	Westwood Ext. S.	135,136
49	49	5	Wakefield Trunk S.	59-41,58-41,87,40
50	50	5	Wakefield Branch S.	50-60
51	51	5	So. Charles Relief S.	4H,4G,4F, 3E,3F
52	52	5	So. Charles River S.	5C
53	15	6	Inner Harbor Comb. S. Overflows	

1. Acceptable to EPA.

TABLE 7-4. FUNDING REQUIREMENTS FOR ALTERNATIVE CONSTRUCTION STAGING PROGRAM WHERE SECONDARY TREATMENT IS POSTPONED

Priority No.	Total cost, $
1	$285,362,000(1)
2	124,547,000
3	58,336,000
4	17,612,000
5	283,502,000
6	86,000,000
Total	$855,359,000(2)

1. Add $4,132,000 to cover primary tanks at Nut Island.
2. Does not include Localized Remedial Measures for Combined Sewers (approximately $13,000,000) which should be carried out throughout the project.

Priority 2 Projects. Major items included as Priority 2 Projects include the infiltration/inflow analysis for the North System; upgrading of several major pumping stations; and abatement of combined sewer overflows in the Neponset and Charles River areas.

Priority 3 Projects. The major item included in Priority 3 is the expansion of primary treatment facilities at the Deer Island Treatment Plant.

Priority 4 Projects. Numerous interceptor facilities are included in the Priority 4 grouping consisting of relief lines, and new lines to sewer additional communities. Additional communities that are expected to be added and require new extensions are Hopkinton, Southborough, Lynnfield, Weston, Lincoln and Sharon.

Priority 5 Projects. The major items included in the Priority 5 work program include the addition of secondary treatment capabilities at the Deer and Nut Island treatment plants and expansion of sludge management facilities associated with these additions.

Priority 6 Projects. As before, the item listed as Priority 6 in the construction staging program relates to the abatement of pollution from Inner Harbor combined sewer overflows.

CHAPTER 8

OTHER TREATMENT OPTIONS

General

In addition to a reorganization of the priorities as presented in Chapter 7, several other options of timing or approach exist. In Chapter 7 the most notable aspect pertaining to a reorganization of priorities from a water quality point of view is the timing of combined sewer overflow remedial measures relative to providing secondary treatment at the Deer Island and Nut Island plants. With regards to available treatment options, there are several which are briefly described in Table 8-1. It must be noted that in all treatment options discussed, sludge management at the Harbor plants would be in accordance with MDC plans to incinerate sludge at Deer Island and not carry on the present practice of discharging digested sludge.

TABLE 8-1. OTHER TREATMENT OPTIONS

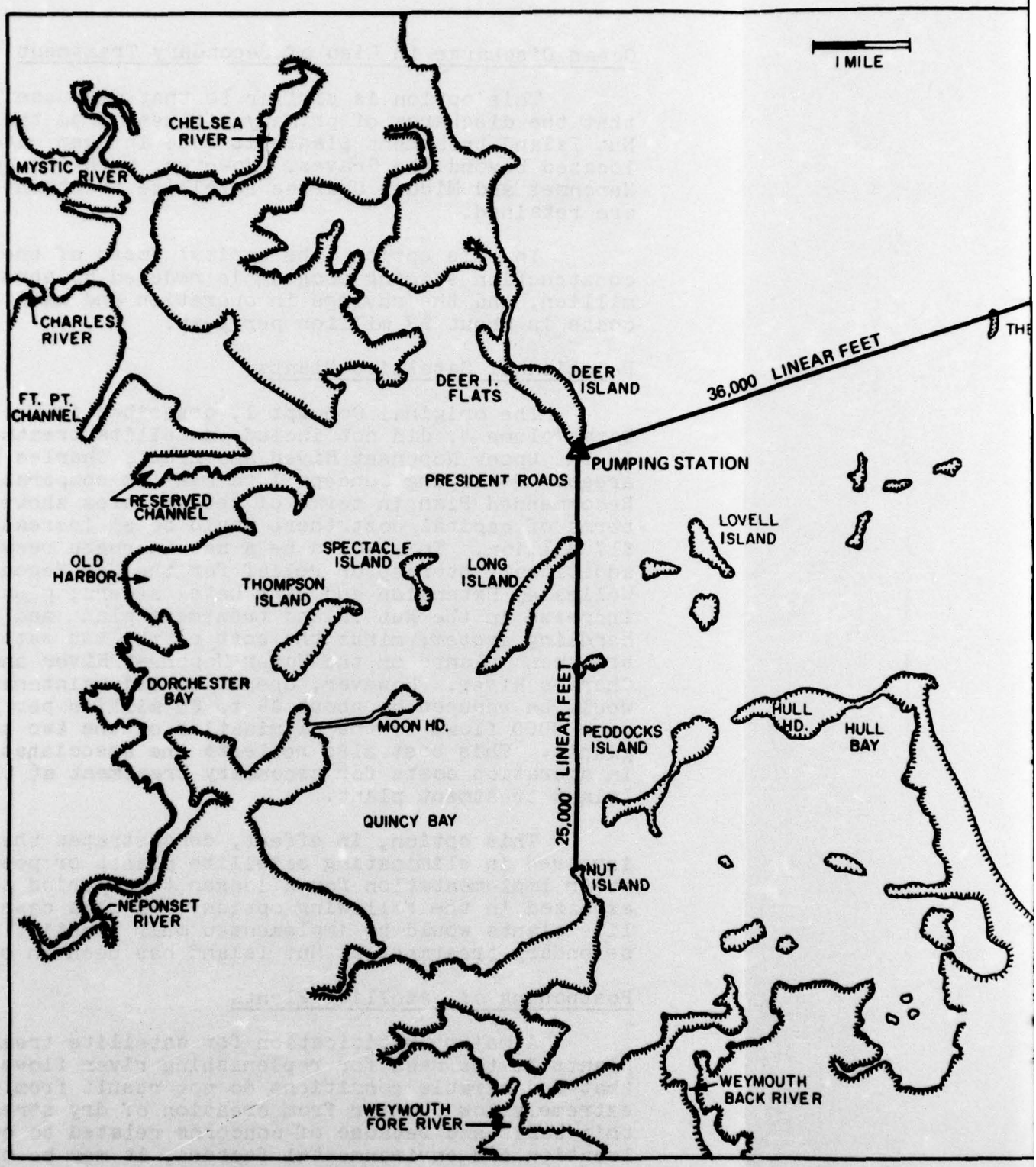
Option	Description
1. Total ocean discharge	No satellite treatment plants. All flows discharged in deep waters after receiving primary treatment at the Harbor plants.
2. Ocean discharge in lieu of secondary treatment	Satellite treatment plants constructed. Primary treatment at the Harbor plants with deep ocean discharge.
3. Deletion of satellite plants	No satellite treatment plants. All flows receiving secondary treatment at the Harbor plants.
4. Postponing of satellite plants	Delayed construction of satellite plants. Upgrade primary treatment at the Harbor plants. Extend treatment capabilities at the Harbor plants to secondary along with construction of satellite plants.

As it has been done in the construction staging program in Chapters 6 and 7, all capital costs are referenced to today's (ENR 2200) prices. Operating costs similarly refer to today's prices, but represent projected year 2000 flows in all cases. It must be pointed out that this study has utilized more detailed bases of cost estimating at each stage of the analysis. Therefore, costs of components among planning process stages cannot be interchanged.

Total Ocean Discharge

This option is based on eliminating the Upper Neponset and Middle Charles satellite treatment plants, and discharging primary effluent from the Deer Island and Nut Island treatment plants in deep waters located beyond the Graves as shown on Figure 8-1. The ocean discharge option is further discussed in Technical Data Vol. 10. For this option, it must be noted that sludge management is retained as currently planned by the MDC and is not discharged through the deep ocean outfall. The savings in capital costs in providing tunnels, a pumping station and diffusers and adding primary settling capabilities to the present plants in place of secondary treatment is about $117 million. The saving in operation and maintenance costs is about $8 to 9 million per year. In evaluating the costs of this option, a point to consider is that a second look at the need for additional relief must be taken in conjunction with infiltration/inflow reduction efforts, especially as the cost of treatment is reduced.

Under the present Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500), the implementation of this option is prohibited because a minimum of secondary treatment would not be provided at the Deer Island and Nut Island treatment plants. It is presented, however, in anticipation that, as funding may become limited, priorities of investment could be shifted along with a change in either the timing or treatment requirements of the Act and other less costly solutions may be chosen in arriving at a clean Eastern Massachusetts Metropolitan Area (EMMA) shoreline. Also, further detailed environmental analyses may show that the filling of areas in the Harbor or use of other lands for treatment plant expansion may be environmentally less acceptable than a deep ocean discharge following primary treatment. This consideration is, however, predicated on carrying out industrial wastes pretreatment requirements for the exclusion of wastes incompatible with treatment and receiving water quality.


1 MILE
CHELSEA RIVER
MYSTIC RIVER
CHARLES RIVER
FT. PT. CHANNEL
DEER I. FLATS
DEER ISLAND
36,000 LINEAR FEET
PUMPING STATION
PRESIDENT ROADS
RESERVED CHANNEL
LOVELL ISLAND
SPECTACLE ISLAND
LONG ISLAND
OLD HARBOR
THOMPSON ISLAND
DORCHESTER BAY
MOON HD.
PEDDOCKS ISLAND
HULL HD.
HULL BAY
25,000 LINEAR FEET
QUINCY BAY
NUT ISLAND
NEPONSET RIVER
WEYMOUTH BACK RIVER
WEYMOUTH FORE RIVER

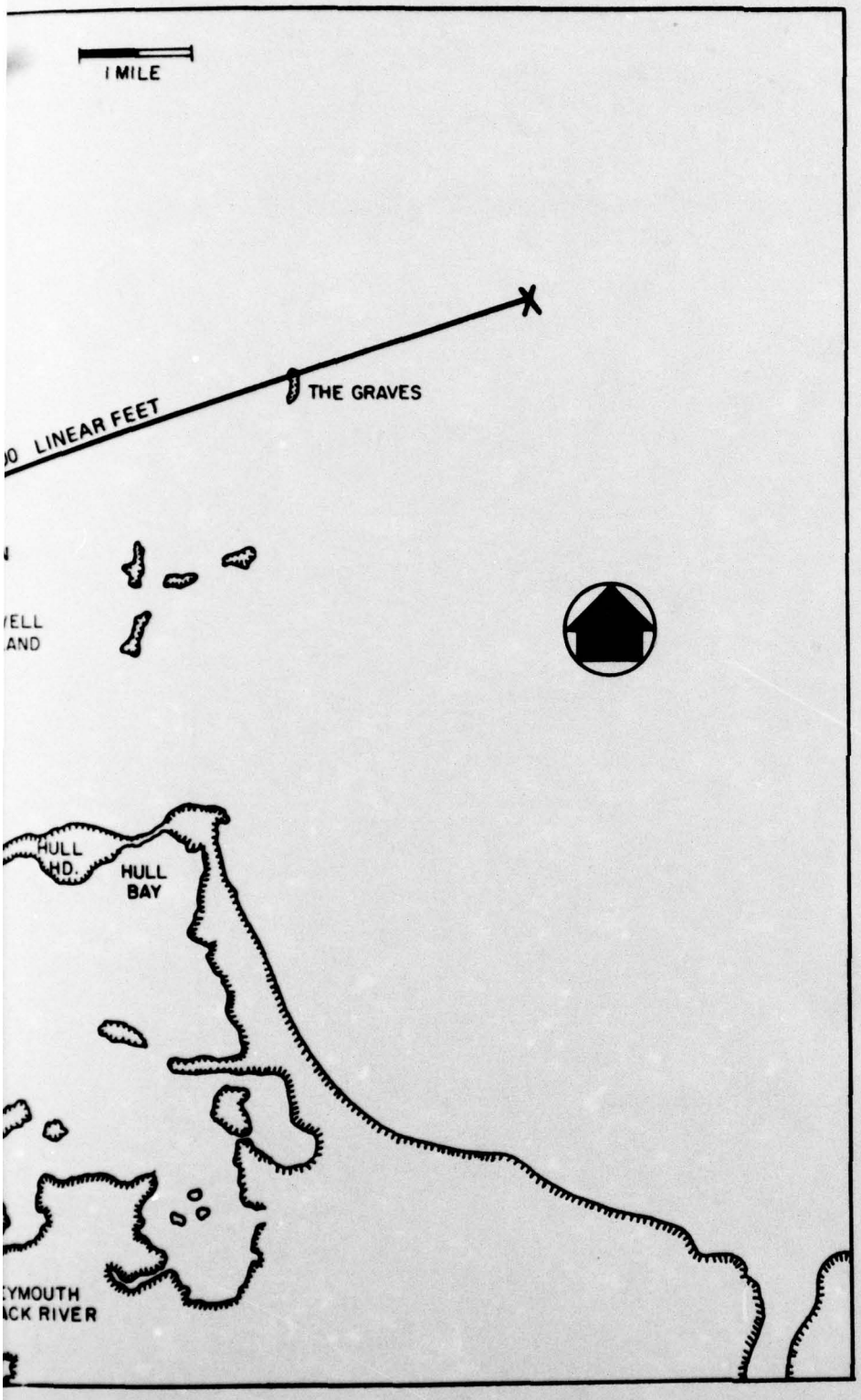


FIG. 8-1 OCEAN OUTFALL DISCHARGE PLAN

Ocean Discharge in Lieu of Secondary Treatment

This option is similar to that discussed above in that the discharge of primary effluent from the Deer and Nut Island treatment plants is made in deep waters located beyond the Graves. However, both the Upper Neponset and Middle Charles satellite treatment plants are retained.

In this option, the capital costs of the recommended construction staging program is reduced by about $100 million, and the savings in operation and maintenance costs is about $3 million per year.

Deletion of Satellite Plants

The original Concept 1, described in Technical Data Volume 4, did not include satellite treatment plants in the Upper Neponset River and Middle Charles River areas. Modifying Concept 1 to make it comparable to the Recommended Plan in terms of service area shows that in terms of capital cost there would be an increase of about $17 million. This would be a net increase resulting from additional interceptor relief for the New Neponset, Wellesley Extension and High Level sewers; plus an increase in the Nut Island treatment plant and the sludge handling system; minus the cost of the two satellite treatment plants on the Upper Neponset River and Middle Charles River. However, operation and maintenance costs would be reduced by about $4 to $5 million per year for year 2000 flows by the elimination of the two satellite plants. This cost also reflects the associated increase in operation costs for secondary treatment at the Nut Island treatment plant.

This option, in effect, demonstrates the costs involved in eliminating satellite plants or postponing their implementation for a longer time period than expected in the following option. In this case, satellite plants would be implemented only sometime after secondary treatment at Nut Island has been in operation.

Postponing of Satellite Plants

A major justification for satellite treatment plants is the need for replenishing river flows in order that undesirable conditions do not result from expected extremely low flow or from creation of dry streams. On this basis and because of concerns related to cost, site location and environmental factors, it may be that implementation of satellite plants is postponed until all

factors are resolved and undesirably low river flow conditions have become real.

This option is actually one of facility timing and has been discussed as a project sequence alternative in Chapter 7. Further explanations are given here to describe the cost impacts.

If a decision is made to put off immediate implementation of the Upper Neponset and Middle Charles treatment plants to a later date, but before extension to secondary treatment is carried out at the Deer Island and Nut Island treatment plants, certain interceptor relief would be required beyond that in the recommended construction staging program shown in Figure 4-2 in Technical Data Vol. 15. In this case, an additional capital expenditure of $29 million would be required presently for interceptor relief, with possibly another $15 million later, depending on the timing of construction of the satellite plants. However, each year of postponing satellite plants would reduce operation and maintenance expenditures by about $5 million reflecting elimination of the cost of operating these plants along with additional operating costs at the Nut Island plant resulting from increased flows.

Comparison of Costs

The capital costs for each option and for the recommended program are presented in Table 8-2. Operation and maintenance costs comparisons are presented in Table 8-3.

TABLE 8-2. COMPARISON OF CAPITAL COSTS OF RECOMMENDED CONSTRUCTION PROGRAM WITH OTHER TREATMENT OPTIONS

Description	Sequence numbers included(2)	Capital cost, millions of dollars(1) Recommended program	Postponing of satellite plants	Deletion of satellite plants	Ocean discharge in lieu of secondary treatment	Total ocean discharge
Sludge Management (D.I. and N.I. primary)	1	25.6	25.6	27.8	25.6	27.8
I/I Analysis (South System)	2	+1.0	+1.0	+1.0	+1.0	+1.0
Dorchester Bay Combined Sewer Overflows	3	77.0	77.0	77.0	77.0	77.0
I/I Analysis (North System)	4	1.0	1.0	1.0	1.0	1.0
N.I. Primary Plant and Outfall Upgrading	5	50.5	50.5	58.7	40.2	46.2
D.I. Primary Plant Expansion	6	41.9	41.9	41.9	30.1	30.1
D.I. and N.I. Secondary Plant and Sludge Management Extension	7,8 and 9	264.8	264.8	297.5	-	-
Satellite Treatment Plants Implementation	10 and 11	90.7	90.7	-	90.7	-
Neponset River and Charles River Combined Sewer Overflows	12 and 13	107.0	107.0	107.0	107.0	107.0
Inner Harbor Combined Sewer Overflows	15	86.0	86.0	86.0	86.0	86.0
Priority One Interceptor and Pumping Station Upgrading and Relief	14 and 16 through 21	40.6	70.1(3)	84.9(3)	40.6	84.9(3)
Priority Two Interceptor and Pumping Station Upgrading and Relief	22 through 32	16.5	16.5	16.5	16.5	16.5
Priority Three Interceptor and Pumping Station Upgrading and Relief	33 through 36	16.4	16.4	16.4	16.4	16.4
Priority Four Interceptor and Pumping Station Upgrading and Relief	37 through 44	17.6	17.6	38.0(4)	17.6	38.0(4)
Priority Five Interceptor and Pumping Station Upgrading and Relief	45 through 52	18.7	18.7	18.7	18.7	18.7
Ocean Discharge Tunnels, Diffusers and Pump Station		-	-	-	187.3	187.3
Total		855.3	884.8	872.4	755.7	737.9

1. Costs shown are on the basis of January 1975 (ENR 2200) prices.
2. See Figure 6-3 for listing of individual projects included.
3. Includes relief for the Wellesley Extension and New Neponset Valley sewers.
4. Includes relief for High Level Sewer.

TABLE 8-3. COMPARISON OF ANNUAL OPERATION AND MAINTENANCE COSTS OF RECOMMENDED CONSTRUCTION STAGING PROGRAM WITH OTHER TREATMENT OPTIONS(1)

Description	Recommended program	Postponing of satellite plants	Deletion of satellite plants	Ocean discharge in lieu of secondary treatment	Total ocean discharge
Middle Charles Treatment Plant					
All year nitrification	3.1	-3.1(2)	-3.1		-3.1
Upper Neponset Treatment Plant					
All year nitrification	2.7	-2.7	-2.7		-2.7
Nut Island Treatment Plant (Without sludge management)					
Primary		-2.0			
Primary without secondary in future				+2.1	
Primary without secondary in future and no sat. plants		+2.3			+2.3
Primary and secondary	3.6		-3.6	-3.6	-3.6
Primary and secondary and no sat. plants			+4.5		
Deer Island Treatment Plant (Without sludge management)					
Primary					
Primary without secondary in future				+6.2	+6.2
Primary and secondary	9.3			-9.3	-9.3
Deer Island and Nut Island Sludge Management					
Primary		-1.9			
Primary without secondary in future				+2.0	
Primary without secondary in future and no sat. plants		+2.1			+2.1
Primary and secondary	2.4		-2.4	-2.4	-2.4
Primary and secondary and no sat. plants			+2.6		
Ocean Discharge Pumping System					
Primary discharge				+1.7	
Primary discharge and no sat. plants					+1.8
Total changes in cost from recommended program	0	-5.3	-4.7	-3.3	-8.7
Total dry weather	21.1	15.8	16.4	17.8	12.4
Total combined sewers	4.5	4.5	4.5	4.5	4.5
Grand total	25.6	20.3	20.9	22.3	16.9

1. Costs shown are in millions of dollars per year at January 1975 (ENR 2200) prices on the basis of future flows.
2. Minus signs represent a reduction in cost as compared to Recommended Program.